DISTRIBUTION RELIGION

THE IMAGE PROCESSOR MAY BE COPIED BY INDIVIDUALS AND NOT-FOR-PROFIT INSTITUTIONS WITHOUT CHARGE. FOR-PROFIT INSTITUTIONS WILL HAVE TO NEGOTIATE FOR PERMISSION TO COPY. I THINK CULTURE HAS TO LEARN TO USE HIGH-TEK MACHINES FOR PERSONAL AESTHETIC, RELIGIOUS, INTUITIVE, COMPREHENSIVE, EXPLORATORY GROWTH. THE DEVELOPMENT OF MACHINES LIKE THE IMAGE PROCESSOR IS PART OF THIS EVOLUTION. I AM PAID BY THE STATE, AT LEAST IN PART, TO DO AND DISEMINATE THIS INFORMATION; SO I DO.

As I am sure you (who are you) understand a work like developing and expanding the Image Processor requires much money and time. The'U' does not have much money for evolutionary work and getting of grants are almost as much work as holding down a job. Therefore, I have the feeling that if considerable monies were to be made with a copy of the Image Processor, I would like some of it.

Put in your own method of returning energy to me here: _____

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

Of course enforcing such a request is too difficult to be bothered with. But let it be known that I consider it to be morally binding.

Much Love,

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NOTES ON THE AESTHETICS OF 'copying-an-Image Processor':

Being a 'copier of many things, in this case the first copier of an Image Processor, I trust the following notes to find meaning to future copiers of Image Processors:

First, it's okay to copy! Believe in the process of copying as much as you can; with all your heart is a good place to start - get into it as straight and honestly as possible. Copying is as good (I think better from this vector-view) as any other way of getting 'there.'

The more you 'buy' the 'copying' of Sandin's encoded intelligence in the I-P, the more you will learn about the man-and-machines. Don't try to make improvements; you'll make it only worse if you modify what already is best, even if it doesn't appear to be the 'best' to your mind's eye. It bothers me very much to see 'folk' laying onto Dan, suggestions of improvement (supposedly) without a thorough giving-in-to understanding of the I-P design. Please realize, that if you 'had-it' to do it you would not be building (copying) an I-P to begin with; you would have done it yourself along time ago...so get to work copying--as-usual.

Dan's evolutionary design of the I-P comes from a very high and thorough CONSCIOUS systems--design-intelligence-level. If you deviate in the process of 'copying' and then Dan makes an improvement on his I-P, you will most likely find it quite frustrating in updating your instrument due to your I-P being incompatible in detail to the original. If you get yourself in a jam, then you have to go to Dan and "$PEND' his time getting you out of it.

So...after all this: the Art of 'copying' is a good form to try on for a year or so while you get into building your Image Processor...enjoy.

PEACE/ASCESIS (love):

Phil Morton

BRIEF SYSTEMS LEVEL DESCRIPTION:

The IP physically is an array of a minimum of approximately 24 modules (aluminum boxes), representing approximately 40 electrical modules.

The documentation that follows is simply a description of how to build the aluminum boxes; the system is considerably more powerful than the sum of the boxes.

On paper a description of how the IP works is more difficult than I am prepared to do. It is best communicated on video-tape; send me a video tape of you best stuff and I will send you a video tape on the IP, and/or send blank tape and $5/hr. (2 hours should do it.)

But in brief, the Image Processor accepts signals = $\pm$ .5 volts 75 ohm including video signals. These signals (images) are distributed into (usually) a number of processing modules and then (usually) mixed out into a standard color encoder (output module). Since most of the processing modules are voltage controllable and control voltages and images are interchangeable, fantastic combinatorial power is possible.

The 'classic' Image Processor contains 8 adder-multipliers, 3 function generators, 3 comparators, 3 amplitude classifiers, 4 oscillators, 3 differentiators, 9 references, 1 sync strip and camera input, 3 inputs, 1 sync generator, 1 color encoder and power supplies. These refer to electrical modules and not aluminum boxes. This constitutes a very powerful processing instrument and because of systems power level (inter-connect-ability), I recommend building approximately this much.

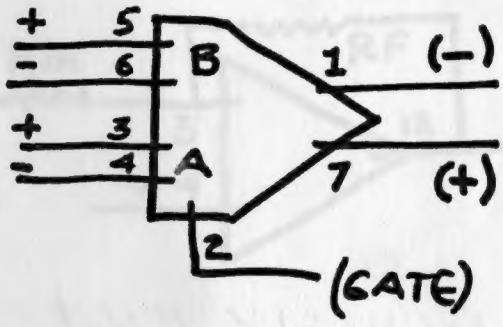
MC 1445 Gain Controlled Amplifier (multiplier):

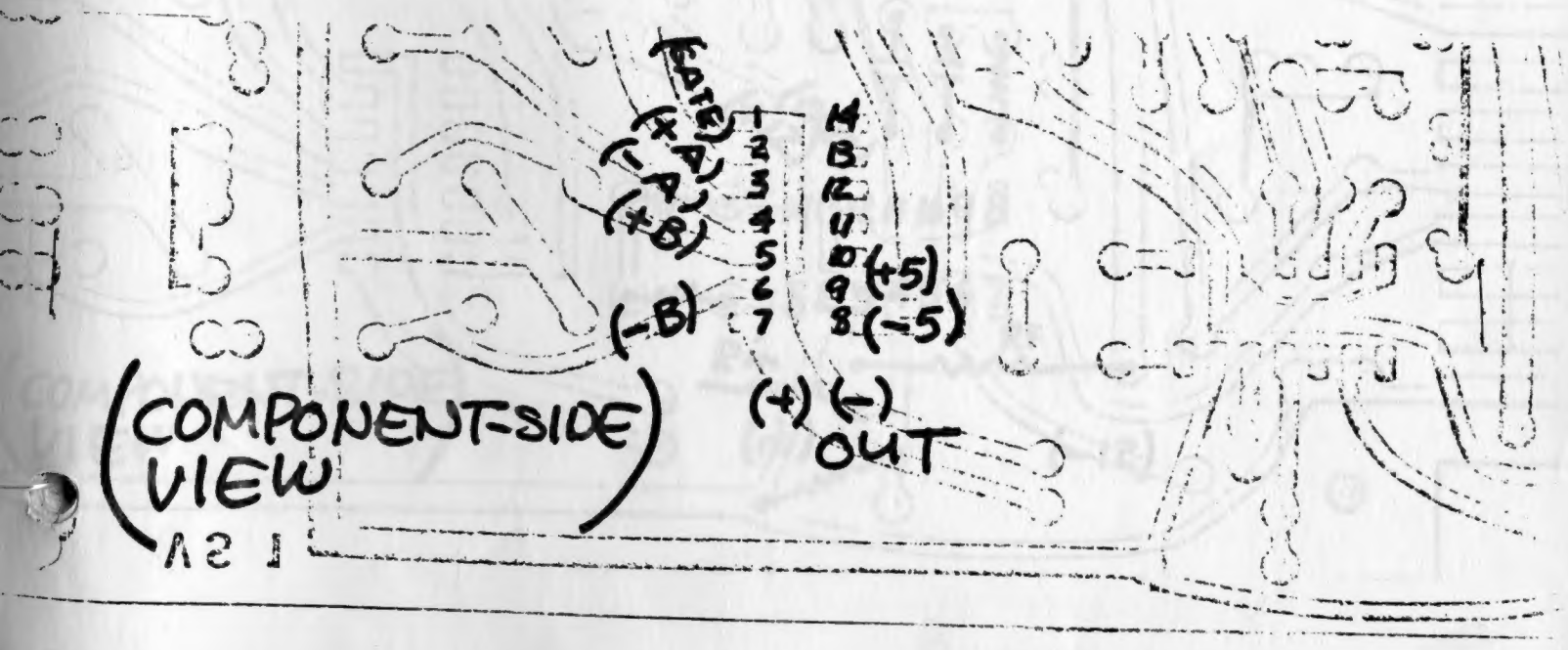
Detailed information on this integrated circuit is available from Motorola Linear Integrated Circuits Manual, available from Motorola or some Motorola distributors.

This I.C. is a four input gain controlled amplifier and is used throughout the IP. Pin (4) is the inverting input to channel A. Pin (3) is the non-inverting input to channel A. Pin (5) is the non-inverting input to channel B; pin (6) is the inverting input to channel B. Non-inverting output is available at pin (7); and the inverting output is available at pin (1).

Which input channel is connected to the output is controlled by the gate voltage at pin (2). If this voltage is high (greater than 1 volt) channel B is on; if the gate voltage is low (0 volts) channel A is connected to the output. The gate voltage produces continous control over the gains of the channels such that .5 volts causes both channel A and B to be connected to the output with 1/2 gain each. Full gain is approximately 10.

Power supply voltage (+5 volts) is connected to pin (9) and (-5 volts) is connected to pin (8). No other pins are used.



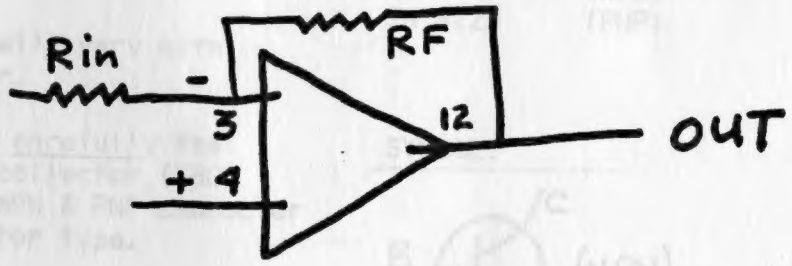


CA 3030 operational amplifier:

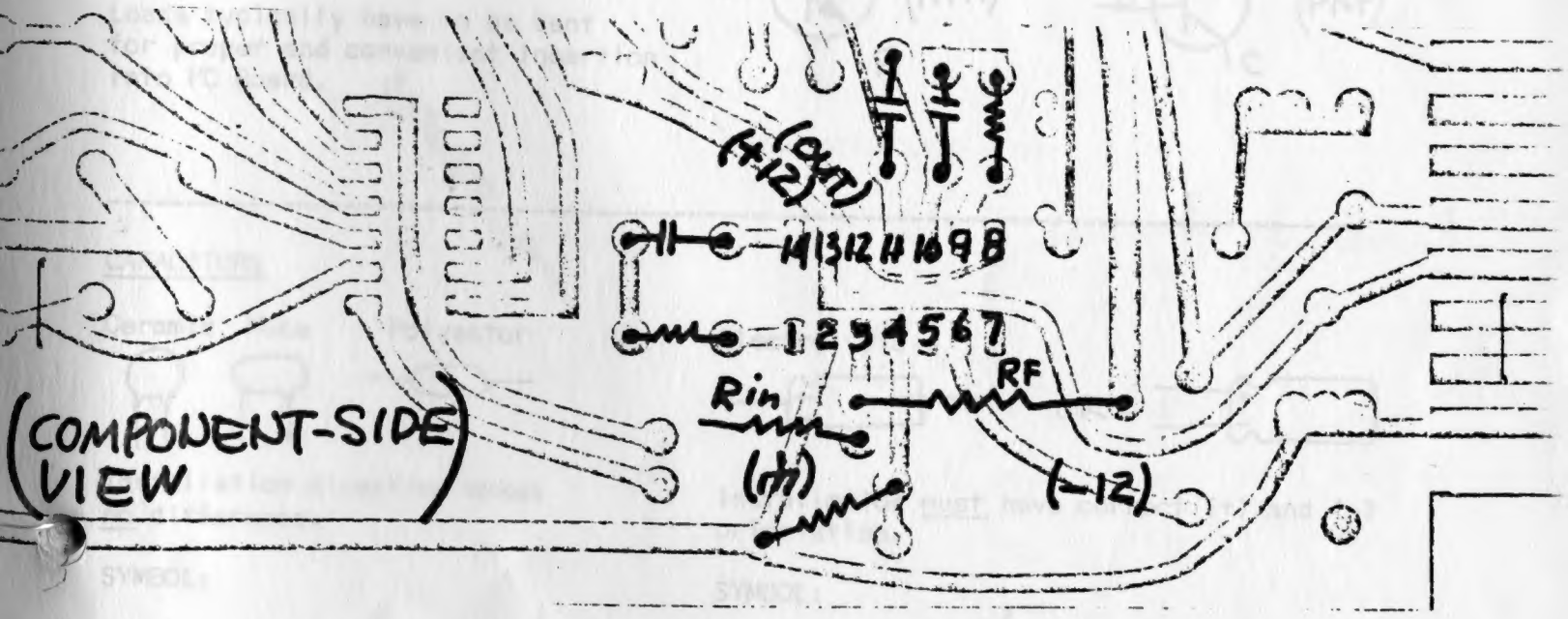
The CA 3030 op amp is used through out the IP. Detailed descriptions of the device are available in the RCA Linear Integrated Circuits Manuel. The book can be gotten from RCA or some distributors of RCA integrated circuits.

What follows is a brief description of the I.C.
The Op Amp has a very large gain (4000). Except in the comparator circuit, this gain is reduced by feedback of a percentage of the output signal pin (12) to the inverting input signal pin (3). A signal to be amplified is applied to pin (3) and will be inverted in the output, or it is applied to pin (4) and is not inverted. Pin (2) is grounded always. Pins (1,14,9,10,11) have to do with compensation for the amplifier which controls the tendency of the amplifier to oscillate (put out a signal of its own). The positive supply voltage (+12v.) is applied to pin (13); negative supply voltage (-12v.) is applied to pin (6). Pin (8) is sometimes connected to the output pin (12) to increase the power available from the I.C.

In simple inverting amplifier circuits, the voltage gain of the amplifier is the ratio of the feedback resistor between pin (12) and pin (3) to the input resistor connected from the input signal to pin (3).
RF/R in



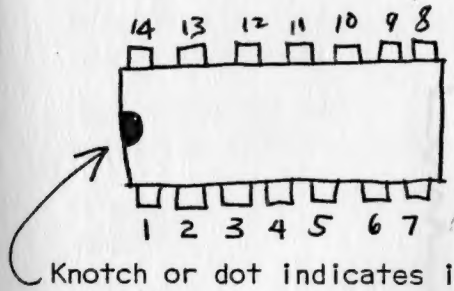
3030A right



INTEGRATED CIRCUITS

Dual Inline Packages (DIP)

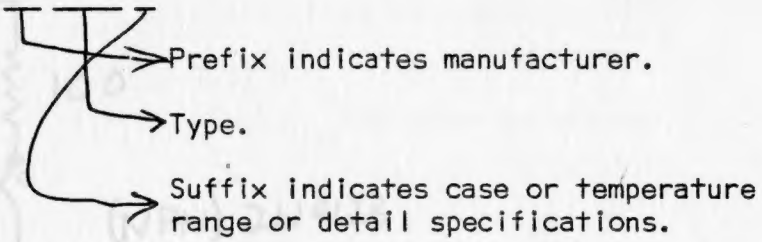
TOP VIEW:



Knotch or dot indicates installation direction.

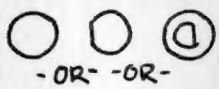
IDENTIFICATION NO. (example):

MC 1445 L



TRANSISTORS

TOP VIEW:



Physical cases will vary with the manufacturer.

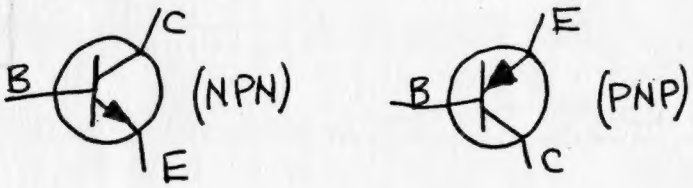
Check and match carefully the emitter, base, collector (EBC) leads with the NPN & PNP character of each transistor type.

Leads typically have to be bent for proper and convenient insertion into PC Board.

IDENTIFICATION NO.:
(only two transistors used in entire system)

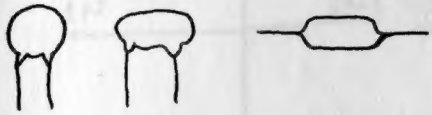
2N 4123 (NPN)
2N 4125 (PNP)

SYMBOL:



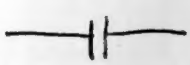
CAPACITORS

Ceramic Mica Polyestor

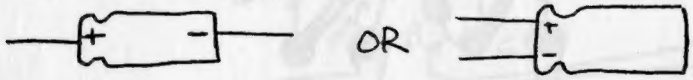


Installation direction makes no difference.

SYMBOL:

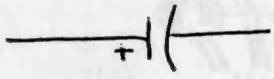


Electrolytic



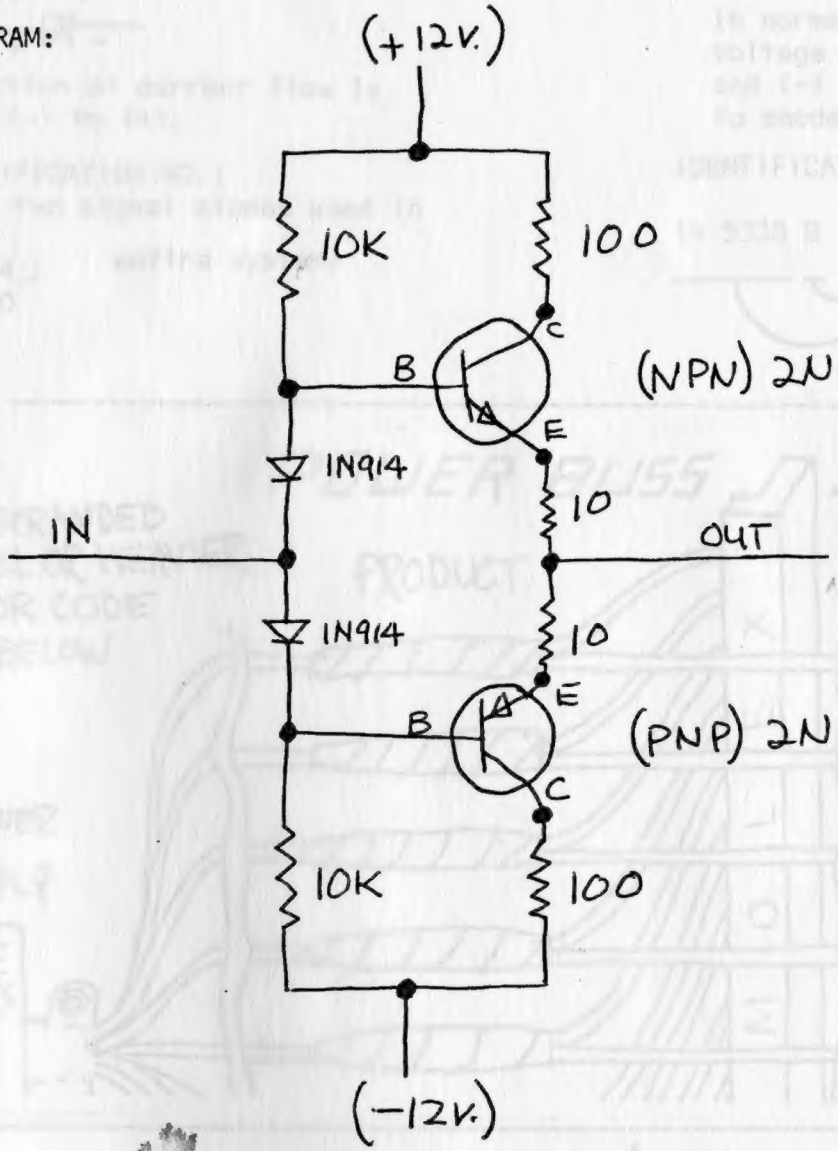
Installation must have correct (+) and (-) orientation.

SYMBOL:

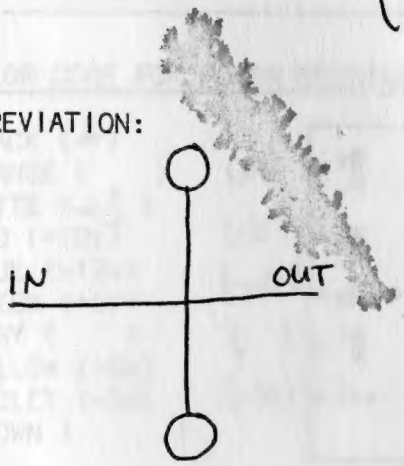


The STANDARD DRIVER is a complimentary current amplifier with voltage gain less than 1. It is used so many times in the I-P that it is abreviated:

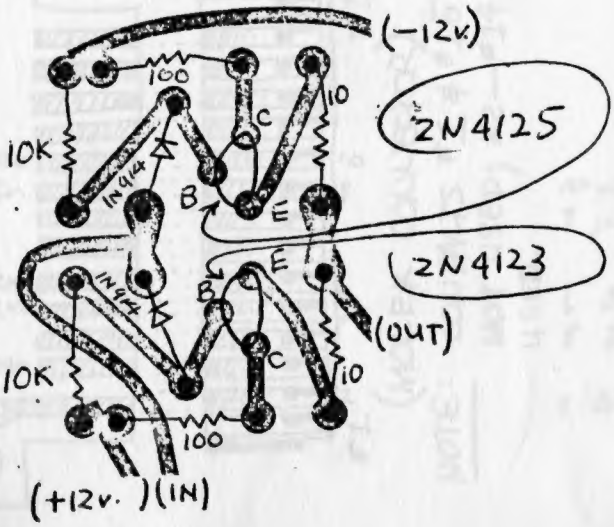
DIAGRAM:



ABREVIATION:

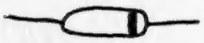


COMPONENT SIDE VIEW:



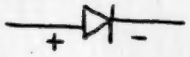
DIODES

COMPONENT:



Band or dot indicates the cathode (-).

SYMBOL:



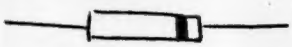
Direction of current flow is from (-) to (+).

IDENTIFICATION NO.:
(only two signal diodes used in entire system)

1N 914
1N 270

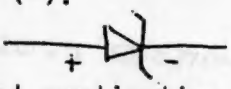
ZENER DIODES

COMPONENT:



Band or dot indicates the cathode (-).

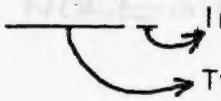
SYMBOL:

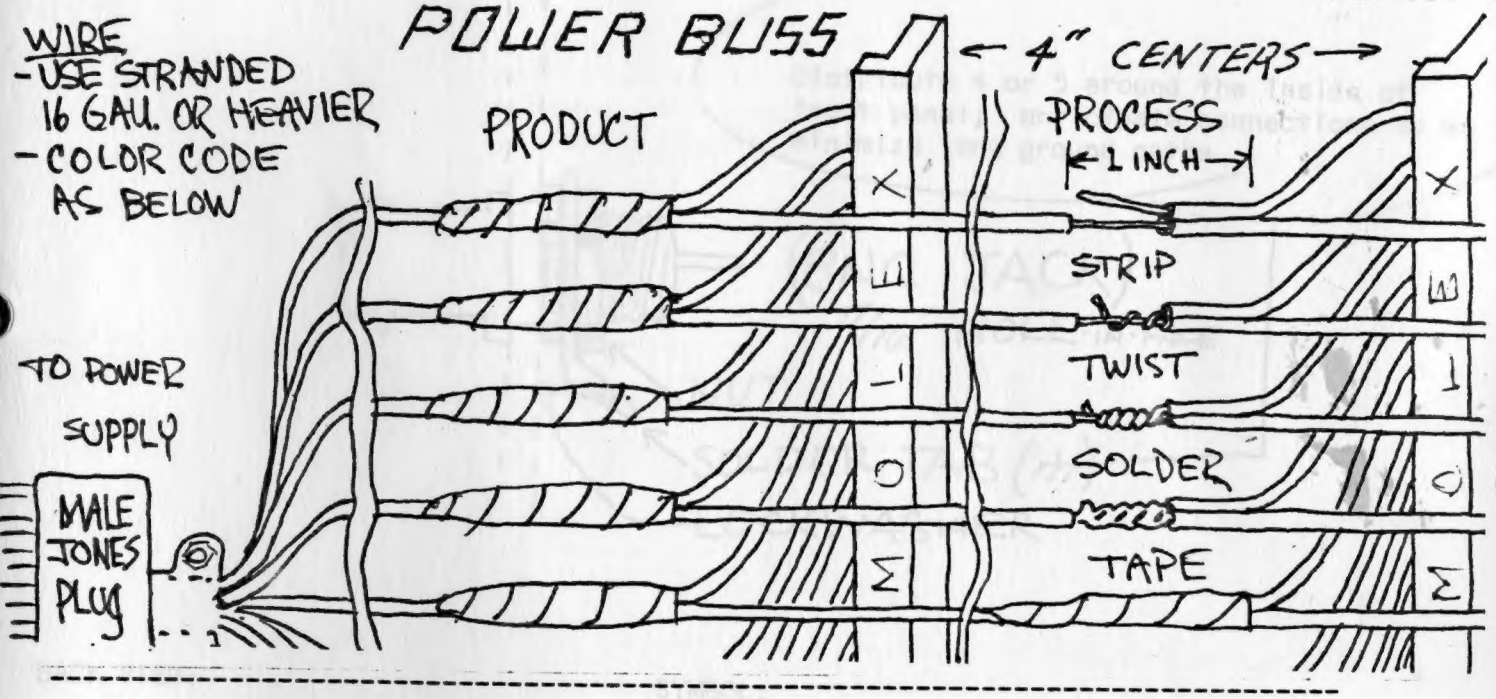


In normal application (+) supply voltage is supplied to cathode and (-) supply voltage is supplied to anode.

IDENTIFICATION NO. (example):

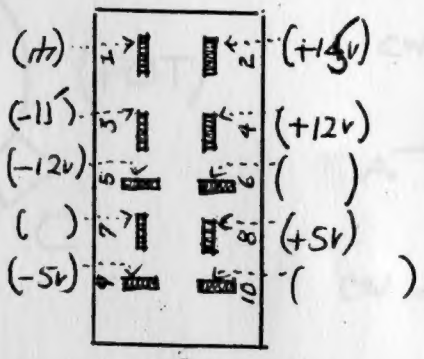
1N 5338 B



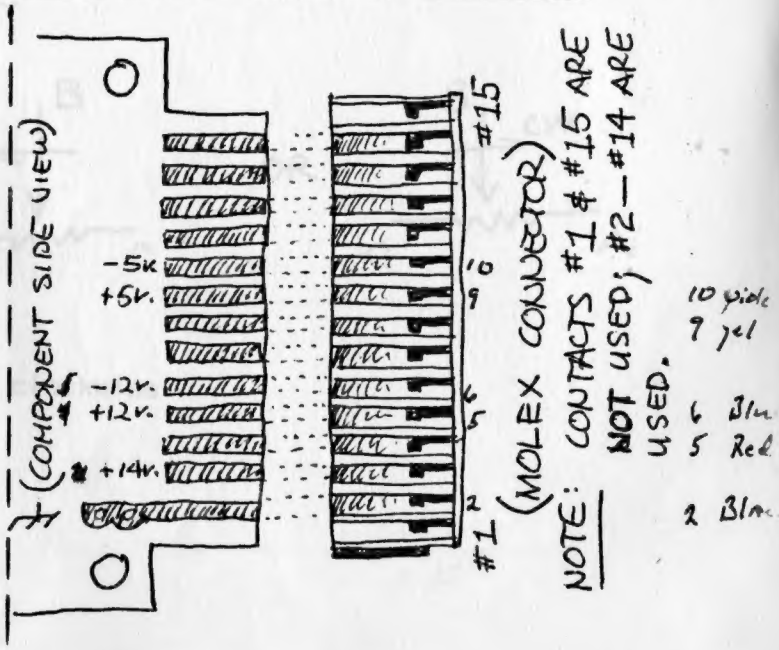


COLOR CODE FOR POWER BUSSING

1. BLACK (gnd)
2. ORANGE ( )
3. WHITE ( )
4. RED (+12v)
5. BLUE (-12v)
6. GREEN (+6v)
7. GRAY ( )
8. YELLOW (+5v)
9. VIOLET (-5v)
10. BROWN ( )

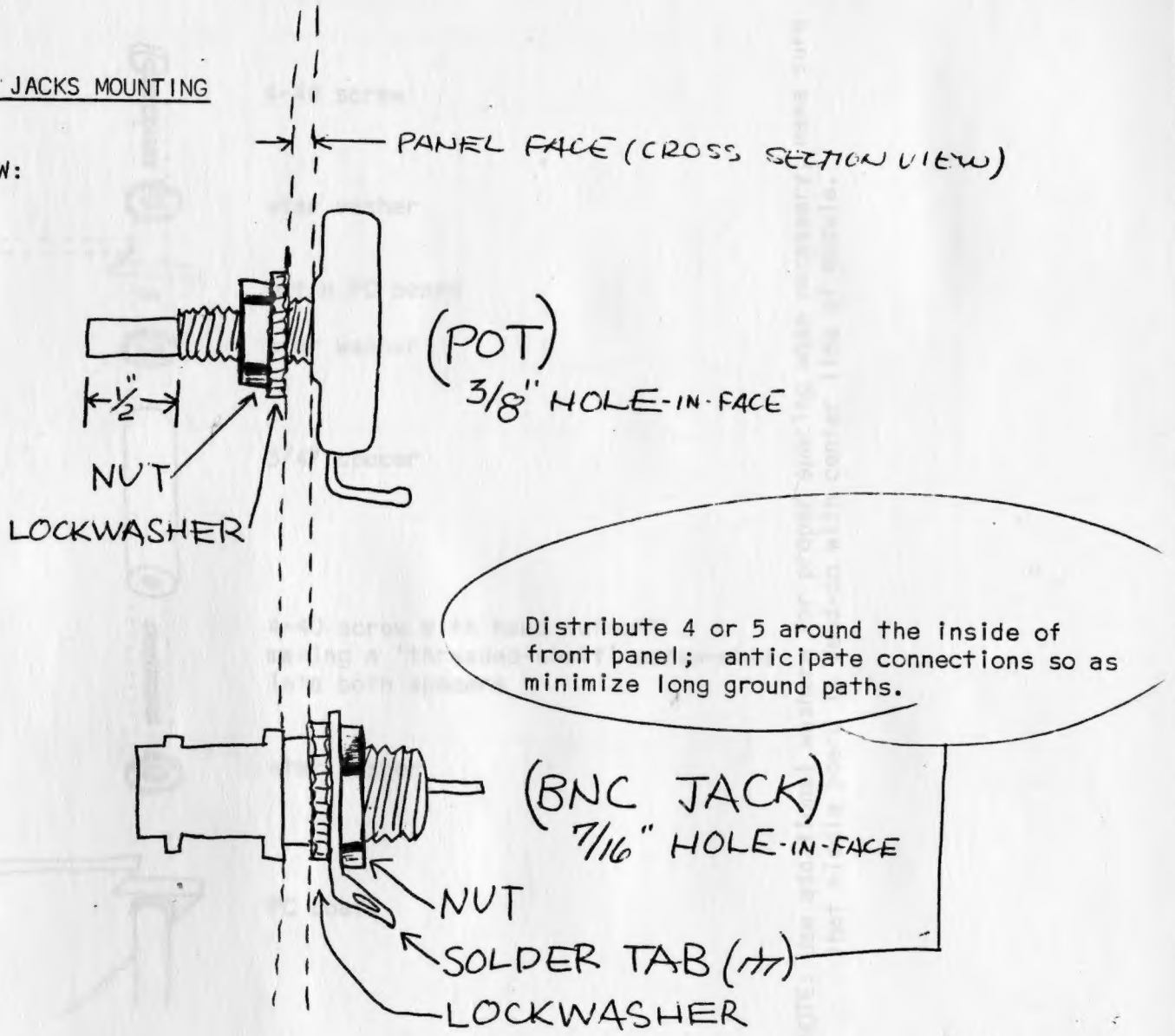


NOTE: All power supply lines into PC board are by-passed to ground (gnd) with a 100mF 25wvdc electrolytic capacitor (indicated in pictorials only).

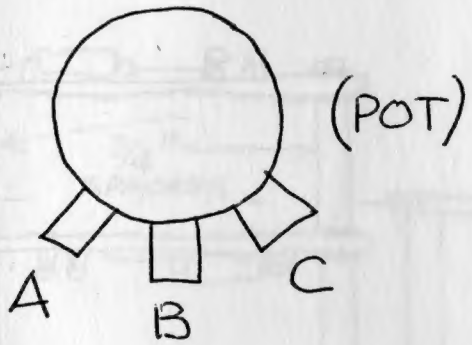


POTS and JACKS MOUNTING

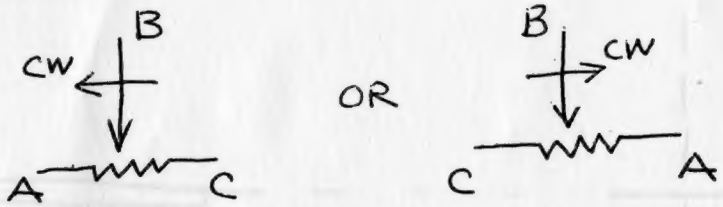
SIDE VIEW:



BACK VIEW:

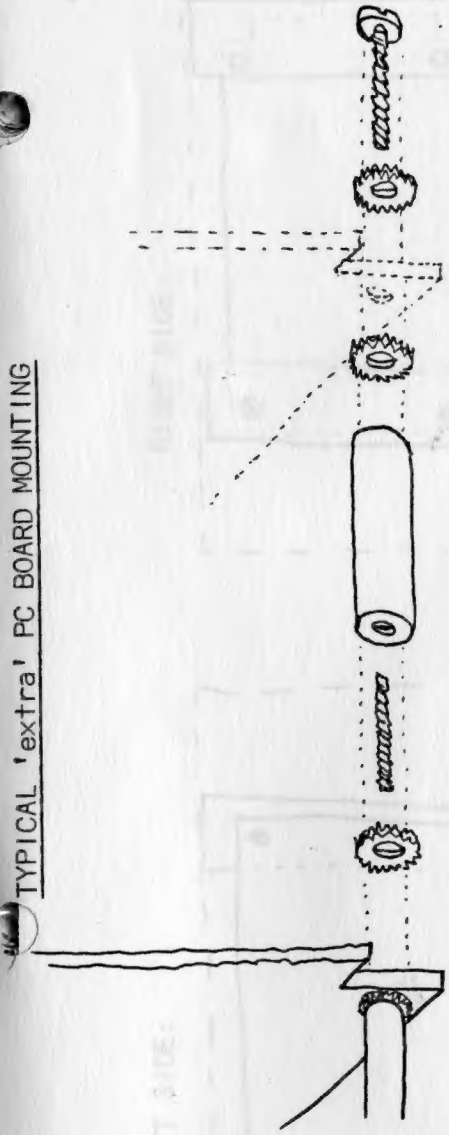


SYMBOL:



CW = clockwise

TYPICAL 'extra' PC BOARD MOUNTING



4-40 screw

star washer

extra PC board

star washer

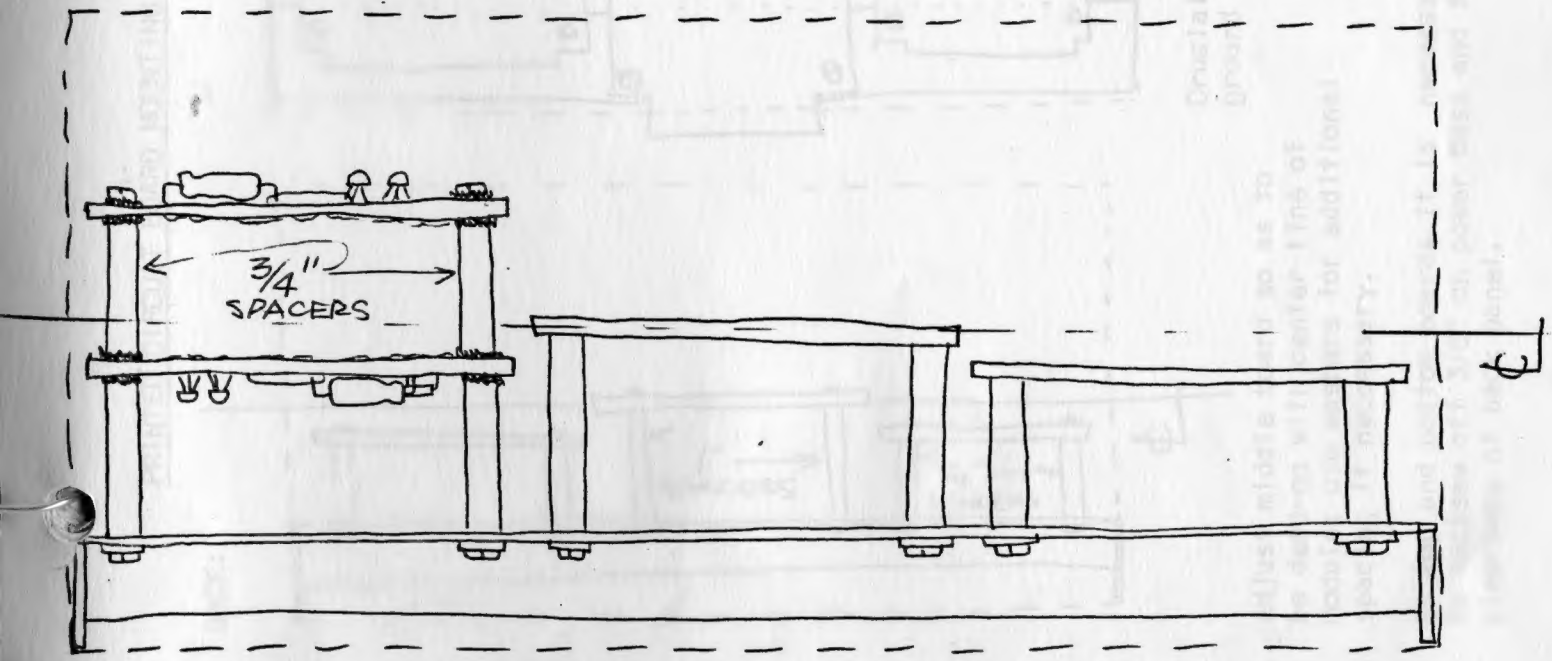
3/4" spacer

4-40 screw with head cut-off
making a 'threaded-shaft' screw-able
into both spacers

star washer

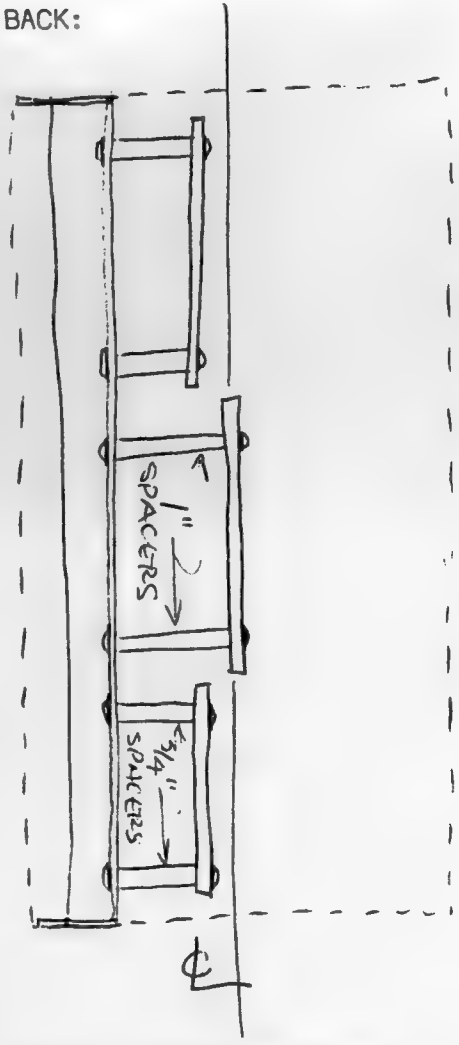
PC board

NOTE: Use additional washers for proper spacing when necessary; make sure that middle board is dead-on with center line of module.



PRINTED CIRCUIT BOARD MOUNTING

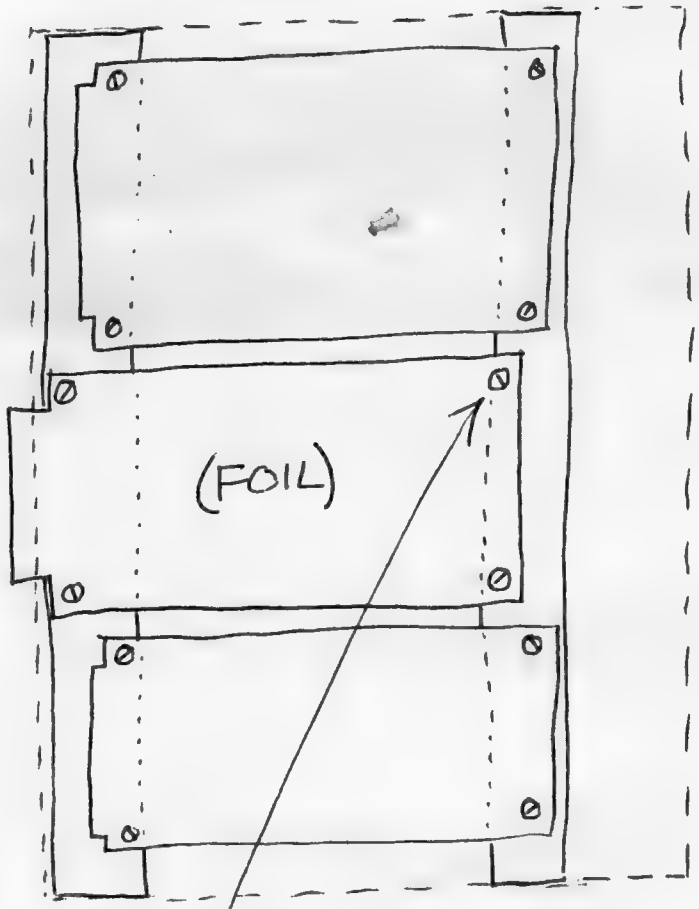
BACK:



Adjust middle board so as to be dead-on with center line of module; use washers for additional spacing if neccessary.

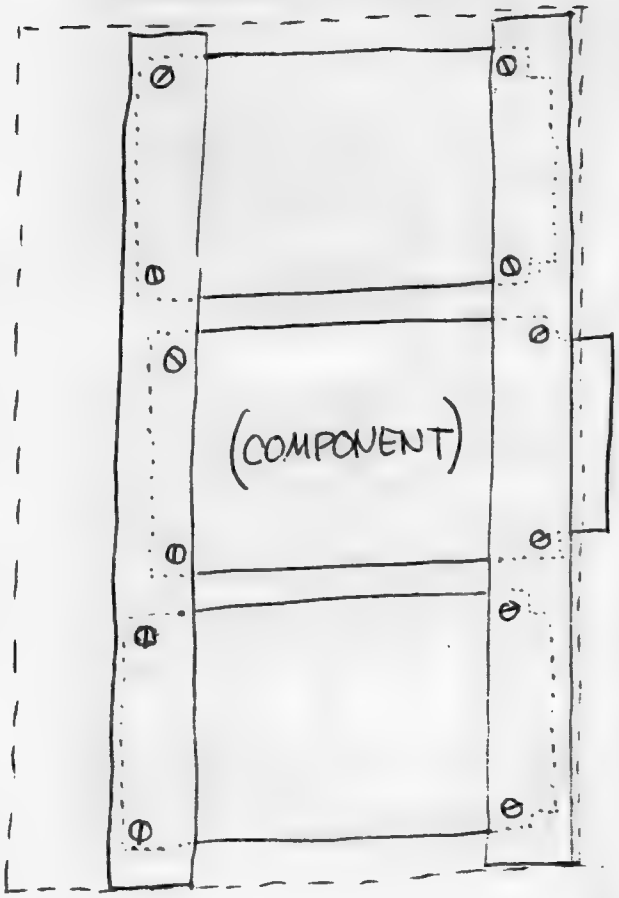
On top and bottom boards it is necessary to hacksaw off 3/8" on power buss end for clearance of back panel.

LEFT SIDE:



Crucial screw; circuits all run to ground (⏚) at this point.

RIGHT SIDE:



Star washer all 4-40 screws which hold boards to supports.

Use #6 x 3/8" panhead self thread - ing screws for mounting supports to chassis box (no washers).

ADDER MULTIPLIER:

The adder multiplier is used to add (superimpose), fade and gain control (multiply) signals.

JI1, JI2, JI3 and the inverted signal of JI7 are added together to form input channel A.

JI4, JI5, JI6 and the inverted signal of JI8 are added together to form input channel B.

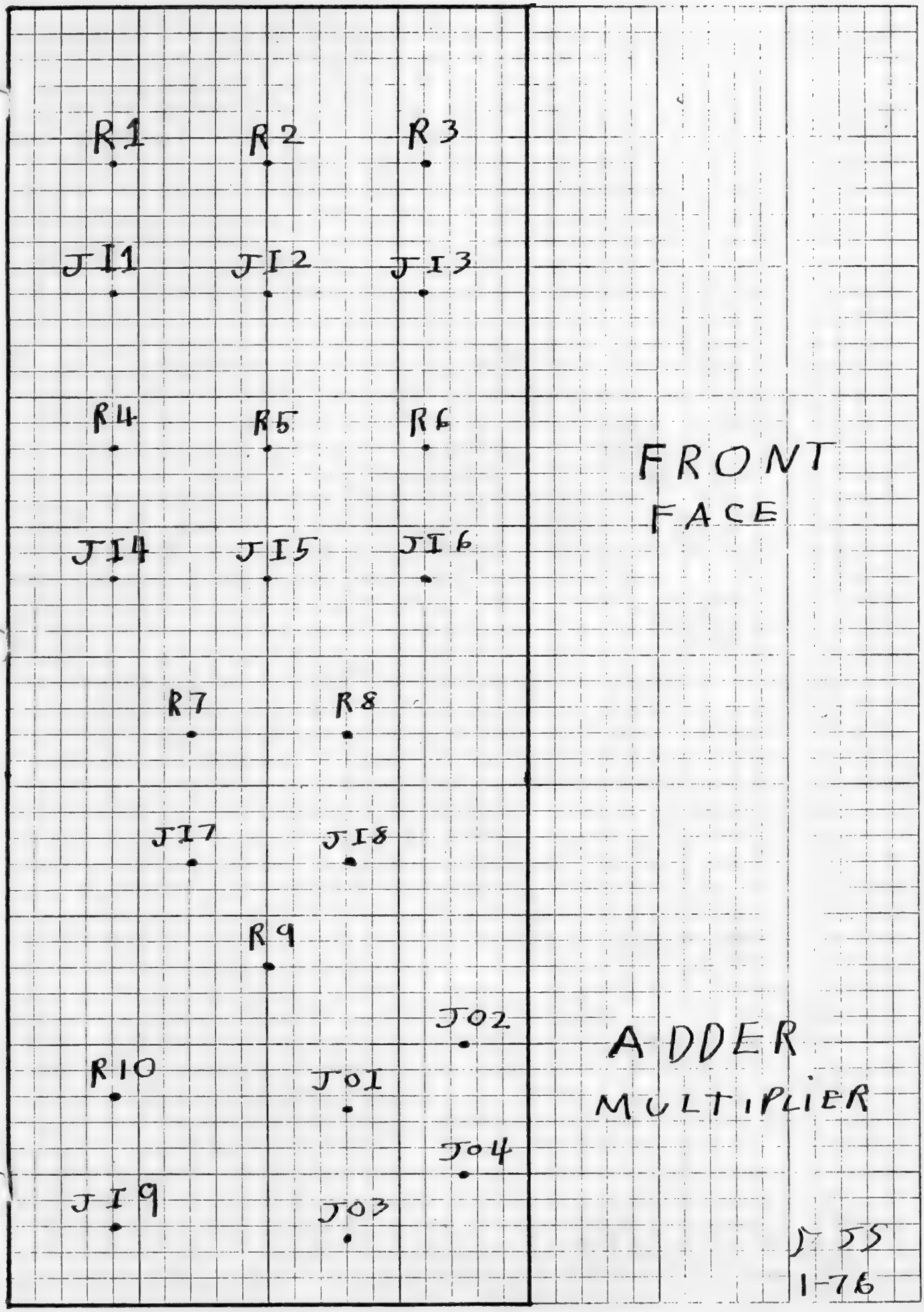
The knobs above the connectors control the gain (contrast) of each individual input.

The amount of channel A and B mixed into the output, JO1 through JO4, is dependent on the position of R9 and the voltage inputted to JI9.
The effect of the knob position and the voltage are additive; the knob to the left and/or a maximum negative voltage on JI9 will cause channel B to be outputted only, similiarly, the knob to the right and/or a maximum positive voltage will cause channel A to be outputted only.
The knob at approximately the center with no voltage applied to JI9 will cause half-of channel A and half-of channel B to be added together and outputted.

TEST STUFF:

The adder multiplier should have a net gain of slightly greater than 1.
That is, a (+) or (-) .5 volt signal into the module should result in an undistorted output of approximately the same magnitude into a 75 ohm load.

With no input the output should be approximately 0 volts (+ or - .05 volts).
Adjust 20k trimmer pot so with R9 in center position and no input to JI9 channel A and channel B have equal gain.


R1
R2
R3
JI1
JI2
JI3
R4
R5
R6
JI4
JI5
JI6
R7
R8
JI7
JI8
R9
JO2
R10
JO1
JO4
JI9
JO3
FRONT
FACE
ADDER
MULTIPLIER
J55
1-76

MINI ADDER MULTIPLIER:

The mini adder multiplier is used to add (superimpose), fade and gain control (multiply) signals.

Knob center - no output
Knob right of center - non inverted output
Knob left of center - inverted output

J11 is the input to channel A.
J12 is the input to channel B.

The knobs above the connectors control the gain (contrast) of each individual input.

When the knob is turned right of center (12:00 0, Clock) signal increases its' non-inverted gain.

When the knob is turned left of center (12:00 0,Clock) signal increases its inverted gain.

The amount of channel A and B mixed into the output, J01 through J08, is dependent on the position of R3 and the voltage inputted to J13. The effect of the knob position and the voltage are additive; the knob to the left and/or a maximum negative voltage on J13 will cause channel B to be outputted only, similiarly, the knob to the right and/or a maximum positive voltage will cause channel A to be outputted only. The knob at approximately the center with no voltage applied to J13 will cause half-of channel A and half-of channel B to be added together and outputted.

TEST STUFF:

The adder multiplier should have a net gain of slightly greater than 1. That is, a (+) or (-) .5 volt signal into the module should result in and undistorted output of approximately the same magnitude into a 75 ohm load.

With no input the output should be approximately 0 volts (+ or - .05 volts).
Adjust 20k trimmer pot so with R9 in center position and no input to J13 channel A and channel B have equal gain.

'MINI' ADDER/MULTIPLIER:

The 'MINI' ADDER/MULTIPLIER is a packed electrical module containing essentially three of the standard ADDER/MULTIPLIERS (as per documentation). The modification involves the elimination of extra inputs, two each for A and B inputs, and the elimination of the separate inverting inputs as was available on the A/M. The 'MINI' ADDER/MULTIPLIER uses 'bi-polar' inputs, one each for A and B inputs to the 1445L's, enabling that signal input to be 'normal' with increasing gain as R1 or R2 is turned clockwise from center, or 'inverting' with increasing gain as R1 or R2 is turned counter-clockwise from center. Extra standard drivers are used to add four additional outputs per sub-module.

The 'MINI' ADDER/MULTIPLIER can be used to add(superimpose), fade and gain-control (multiply) signals.

Knob center R1,R2--no output (zero volts, middle gray)
Knob right of center R1,R2--non inverting output
Knob left of center R1, R2--inverted output

Knobs above inputs control the gain over that input.

Turning R1,R2 right of center increases the signal input non-inverting gain.

Turning R1, R2 left of center increases the signal input inverted gain.

JI1 is the signal input to channel A.
JI2 is the signal input to channel B.

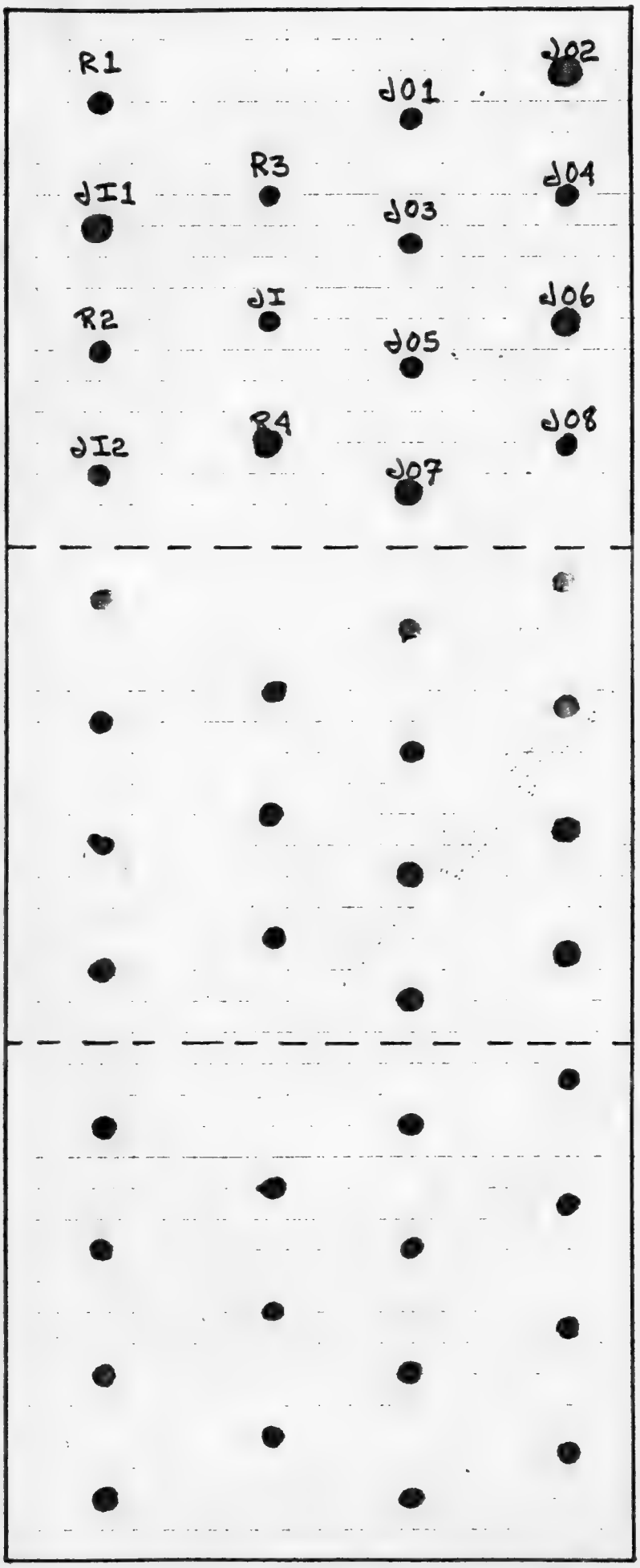
The amount of channel A and B mixed into the output JO1-JO3 is dependent on the position of R4 (BIAS knob) and the voltage inputted to JI3 (multiply input). The effect of the knob position and the voltage at JI3 are additive; the knob to the left and/or a maximum negative voltage at JI3 will cause channel B to be outputted only. Similarily, the knob (R4, Bias) to the right and/or a maximum positive voltage at JI3 will cause channel A to be outputted only. The knob(R4, Bias) at approximately the center with no voltage applied to JI3 will cause half of the signal at A to be added with half of the signal at B and outputted.

TEST STUFF:

The 'MINI' ADDER/MULTIPLIER should have a net gain of slightly greater than 1. That is, a (+) or (-) .5volt signal into the module should result in an undistorted output of approximately the amplitude into 75 ohm load. With no signal input, the output should be zero volts, + or - .05 volts. 'Adjust the 20K trimmer so that with R4 in the center, and precise amplitude signals into A and B (JI1, JI2), and no input to JI3, channel A and B have equal gain at the output.
If you use the 217 board modification, be sure to drill precise holes, cut foil in the correct location, and insulate dc jumper wires.

OK?

11.79 MF



MINI ADDER/ MULTIPLIER

FUNCTION GENERATOR

The function generator generates an output which is an arbitary function (with up to two points of inflection) of the input at J11. This results in an effect that is similiar to but more complex and controllable than photographic solerization.

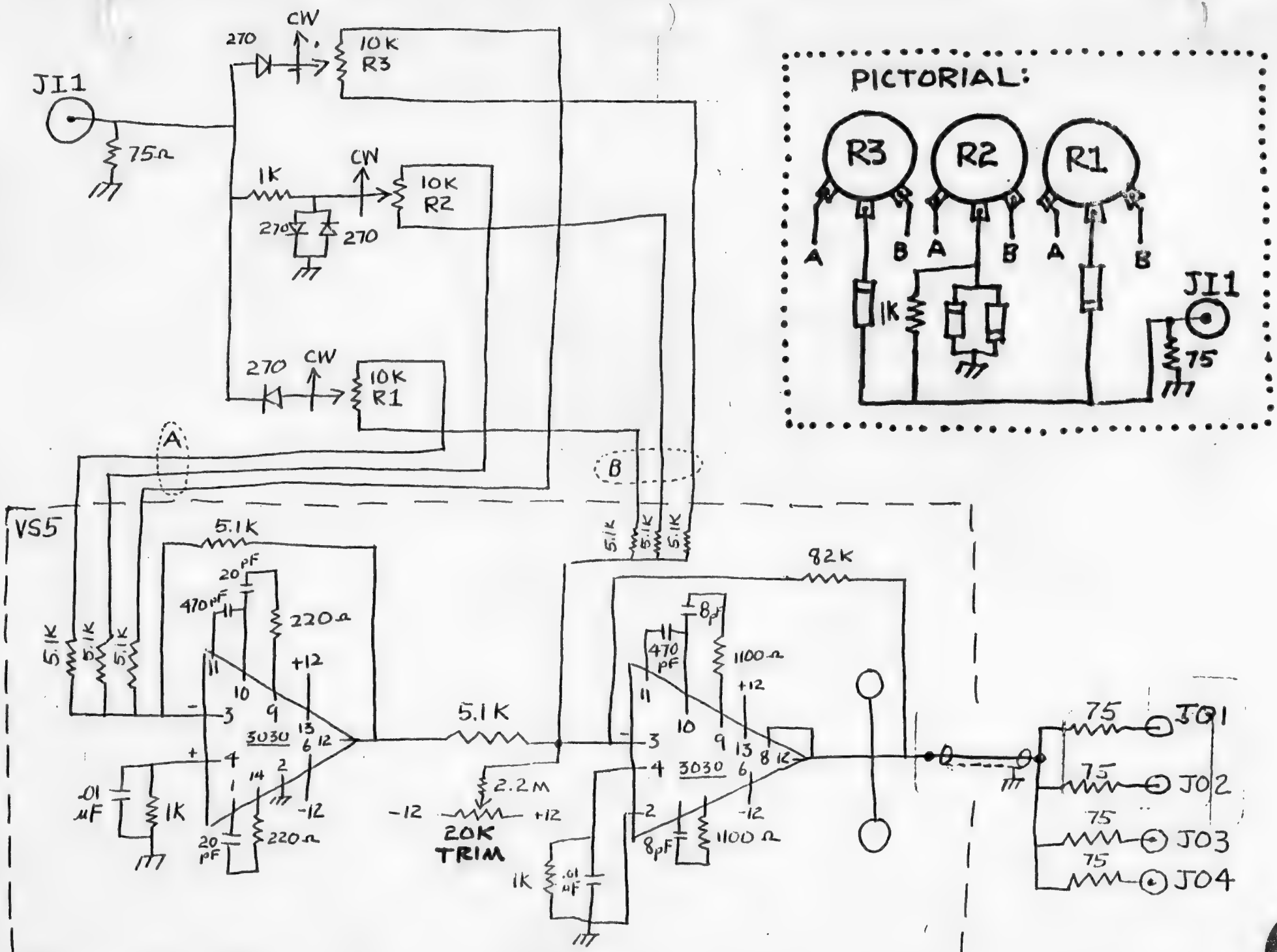
The function is controlled by R1, R2, and R3.
R1 controls the slope of the function for large negative inputs.
R2 controls the slope of the function for inputs near 0 voltages.
R3 controls the slope of the function for inputs of large positive voltage.

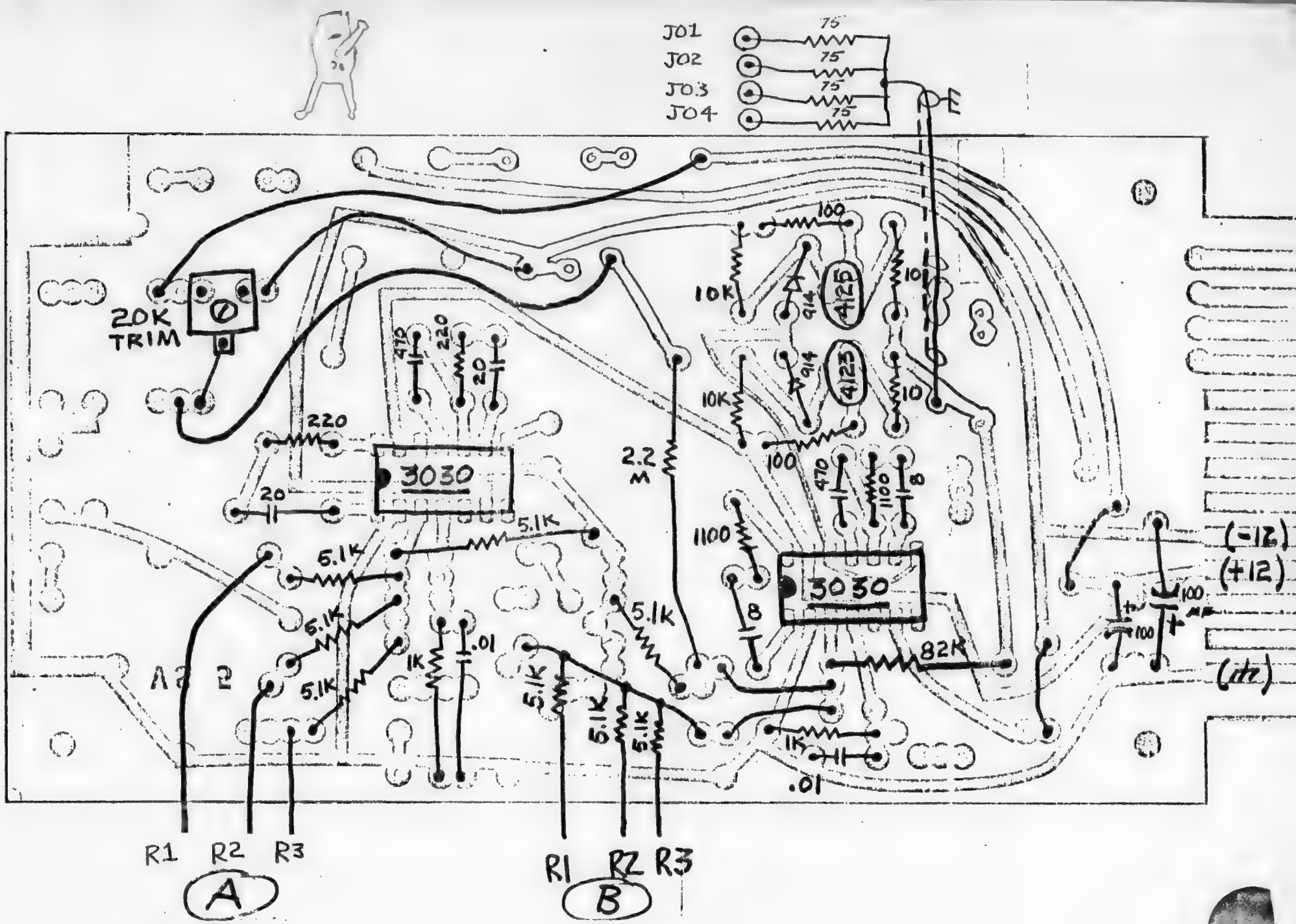
Clockwise is positive slope; counterclockwise is negative slope.

There are three electrical modules in one chassis box, so replicate work three times. Remember to buss (connect) +12 and -12 and ground wires from middle board to top and bottom board. Soldering directly to the foil is convenient.

TEST STUFF:

The 20K trimming resister on the VS5 board is adjusted such that no input results in 0 output voltage + or - .05 volts.


JI1
75Ω
270
CW
10K
R3
1K
10K
R2
270
270
270
CW
10K
R1
A
B
VS5
5.1K
20 pF
470 pF
220Ω
+12
3030
.01 μF
1K
-12
5.1K
2.2M
20K
TRIM
82K
8pF
1100Ω
8.1K
75
JO1
JO2
JO3
JO4
PICTORIAL:
R3
R2
R1
A
B
1K
75
JI1



FUNCTION GENERATOR 9-75

COMPARATOR

The comparator produces an output which is +.5 volts (white) if the input voltage at JI1 is greater (more positive) than the voltage at JI2.

The comparator produces an output which is -.5 volts (black) if the input voltage at JI1 is less (more negative) than the voltage at JI2.

With 0 volts or no input, the output will be either +.5 or -.5 volts into a 75 ohm load, depending on history.

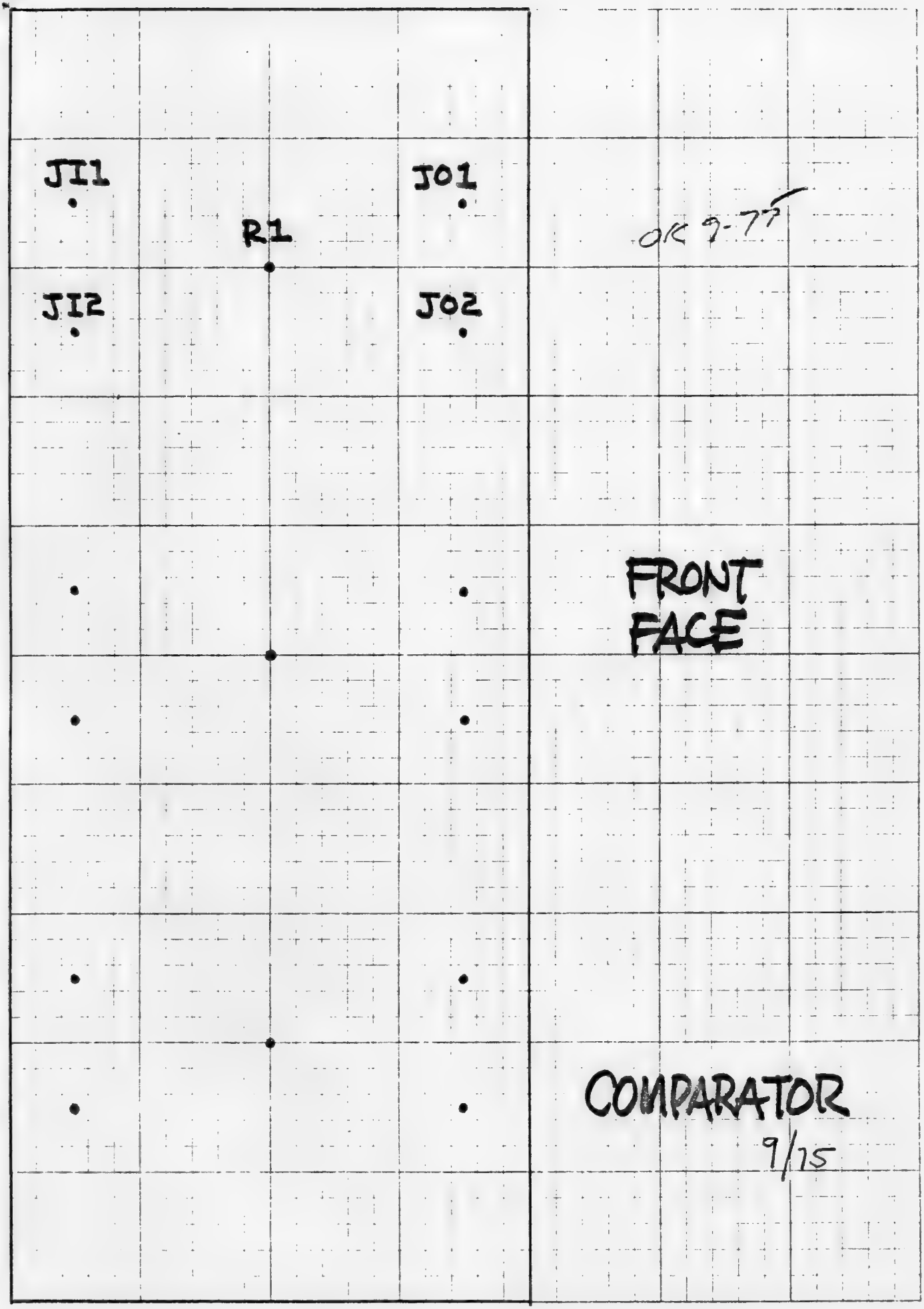
The variable resistor (pot) R1, determines the positive feedback which controls the tendency of the module to stay in the state it is in. Typically it is turned fully clockwise.

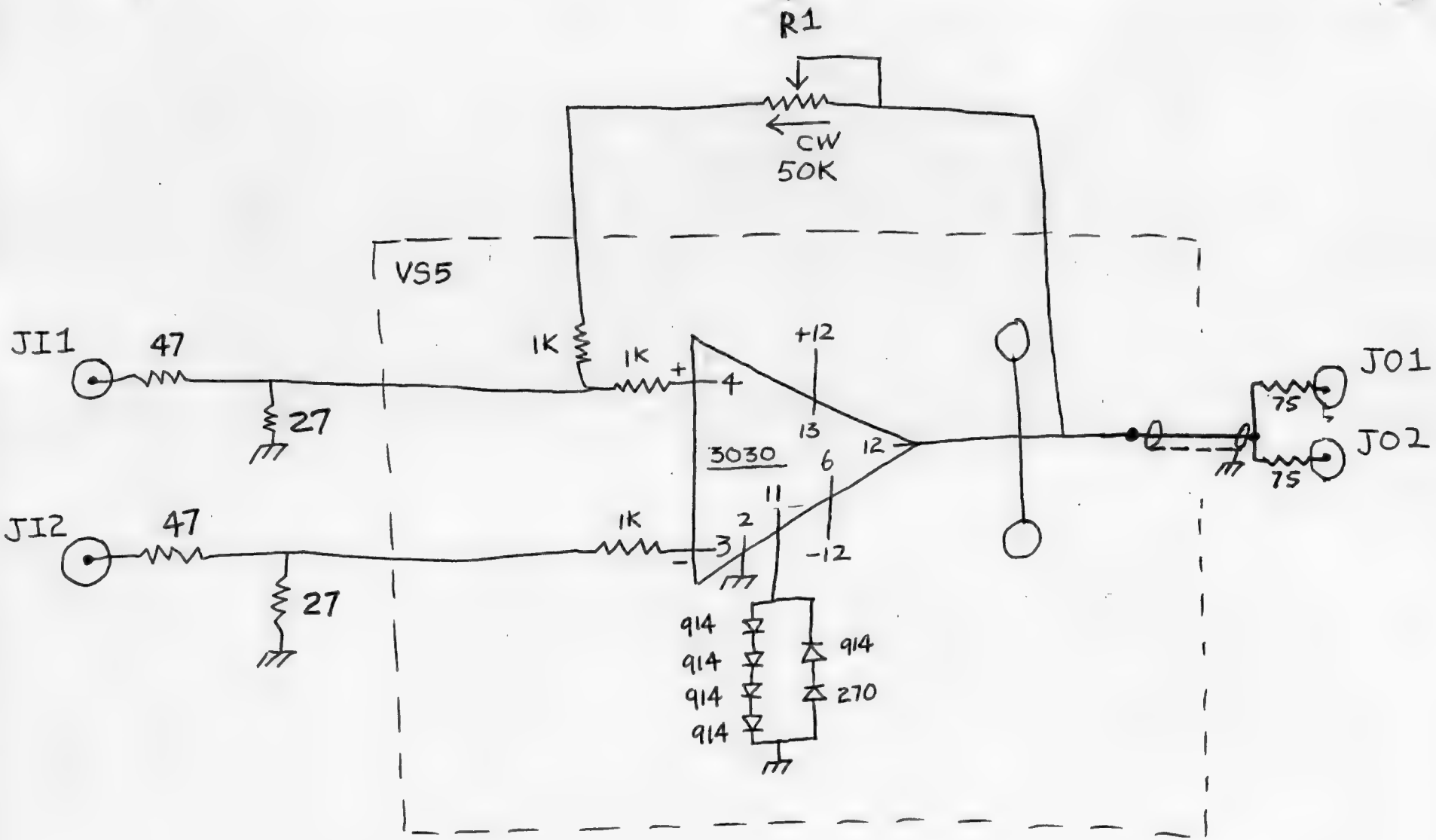
There are three electrical modules in one chassis box, so replicate work three times. Remember to buss (connect) + 12 volts, - 12 volts and ground from the center card to upper and lower cards.

TEST STUFF:

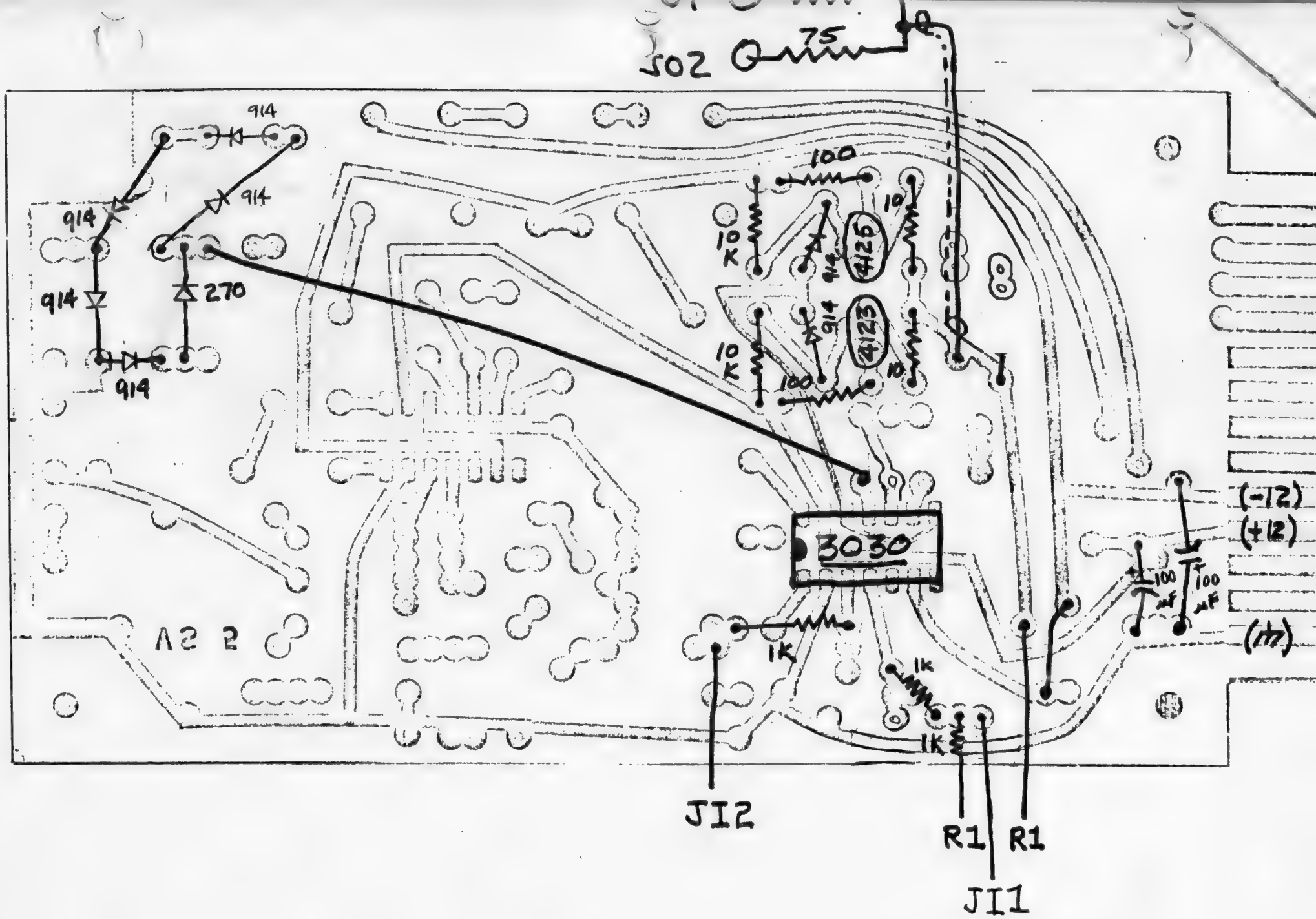
A sine-wave input should produce a clean square-wave output.

The output voltage should be between + or - .5 volts to + or - .75 volts.


JI1
J01
R1
OK 9-7
JI2
J02
FRONT
FACE
COMPARATOR
9/15



COMPARATOR 9-75



COMPARATOR 9-75

AMPLITUDE CLASSIFIER

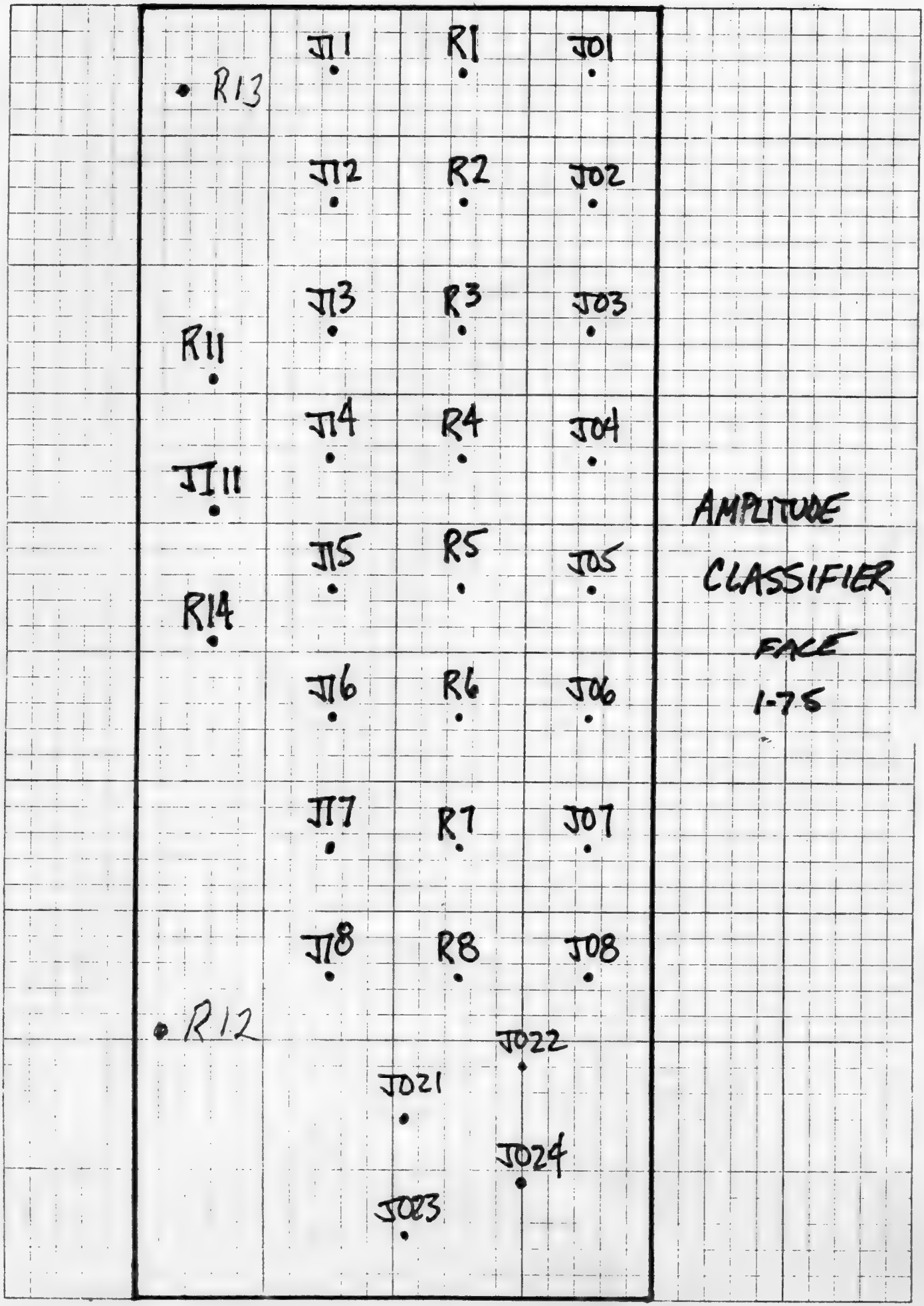
The amplitude classifier takes an input signal at JI 1land separates it into 8 contigeous regions varying from black to white. The value put out by each region is controled by R 1 through R 8 and by signals inputed to JI 1 through JI8. The output signals are available for each region seperately, JO 1 through JO 8. The sum of these signals is available at JO 21 through JO 24. The effect of JI 1, JI2, R 2, etc., is additive in each region. R11 controls the gain of the signal inputed at JI 11, and R 14 generates a bias (constant gray level proportional to knob position) which is added to the input signal. In general, R 11 and R 14 are used to match the incoming signal to the lightest, or 'top and 'darkest' or 'bottom' of the 8 regions.

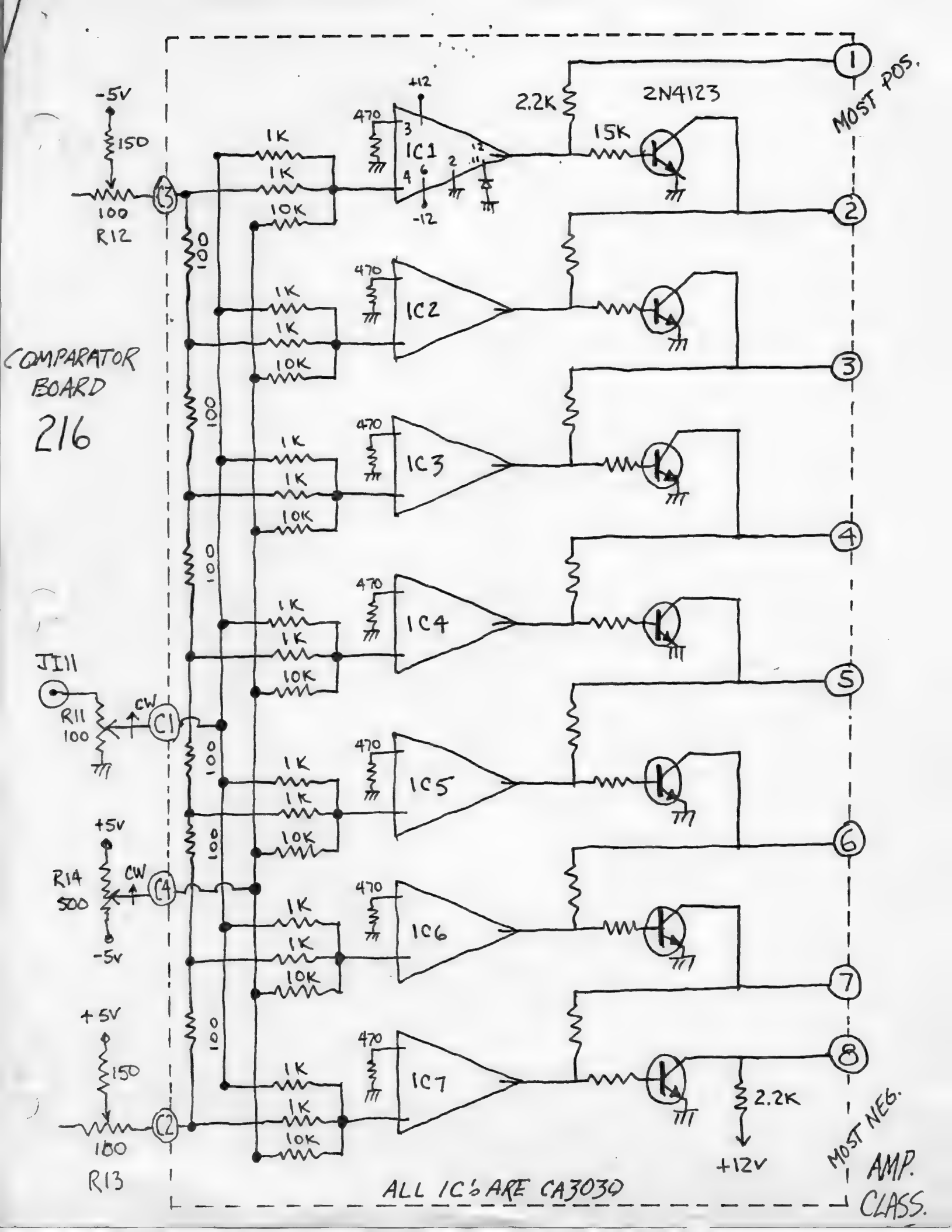
TEST INFORMATION

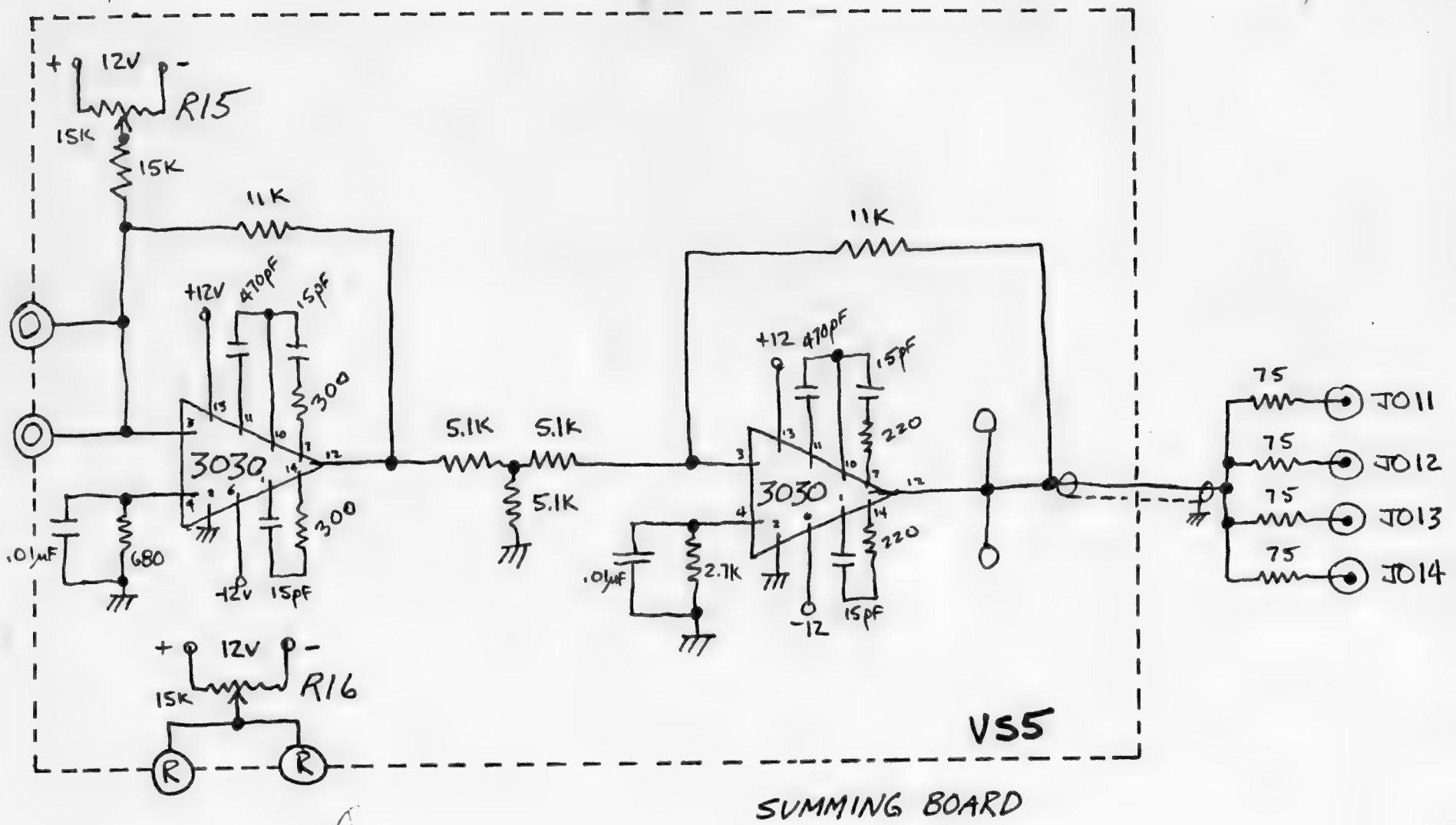
These tests are best performed with a 1 volt, peak to peak triangle wave inputed to JI 11, and a calibrated dual trace oscilloscope connected to the input and output of the amplitude classifier. R 13 is adjusted so that a -.4 volt signal activates channel 8 (bottom). R 12 is adjusted so that a +.4 volt signal activates channel 1 (top). R11 should be full clockwise and R 14 should be in the exact center of rotation. R 12 and R13 interact greatly, so, repeat adjustments until both conditions can be met simultaneously. R 16 should be adjusted so that with R 1 through R 8 in their centers the individual output are near 0 volts when not activated. R 15 should be adjusted so the summed output appearing at JO 21 through JO 24 is 0 volts for the non-activated channels.

BASIC CIRCUIT DESCRIPTION AND TEST INFORMATION--AMPLITUDE CLASSIFIER

A signal at JI11 is sent to all comparators. The resistor string of 100 ohm resistors combined with voltage sources at R 13 and R 12 bias so that IC 1 switches on at a higher (+) voltage than IC 2, IC 2 switches on at a higher voltage than IC 3, etc.. For example; with 0 volts at JI 11, IC 5,6,7 might be on and IC 1,2,3,4 would be off. The transistors connected to the outputs of the comparators decode the comparator string output such that only the highest comparator on is outputed. In this example, channel 5 would be on, all others off. This signal is sent to the multiplier associated with channel 5, turning it on. All other multipliers would be off.

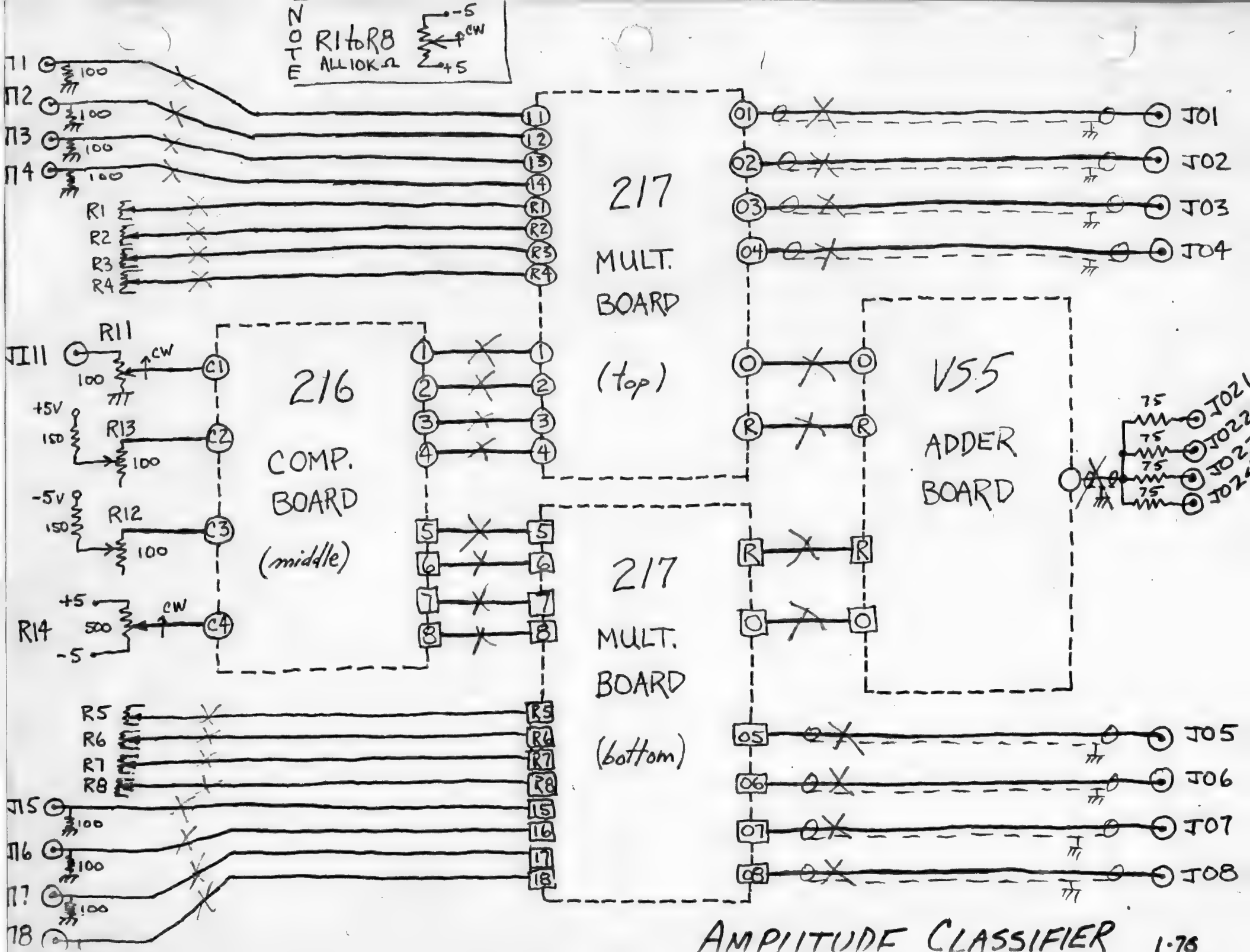

JI1
R1
JO1
R13
JI2
R2
JO2
JI3
R3
JO3
R11
JI4
R4
JO4
JI11
JI5
R5
JO5
R14
JI6
R6
JO6
JI7
R7
JO7
JI8
R8
JO8
R12
JO22
JO21
JO24
JO23
AMPLITUDE
CLASSIFIER
FACE
1-75


COMPARATOR BOARD 216
-5V
150
100
R12
+12
-12
470
IC1
IC2
IC3
IC4
IC5
IC6
IC7
1K
10K
100
2.2K
15K
2N4123
MOST POS.
MOST NEG.
AMP. CLASS.
+12V
J11
R11
100
CW
+5V
R14
500
-5V
R13
ALL IC's ARE CA3030

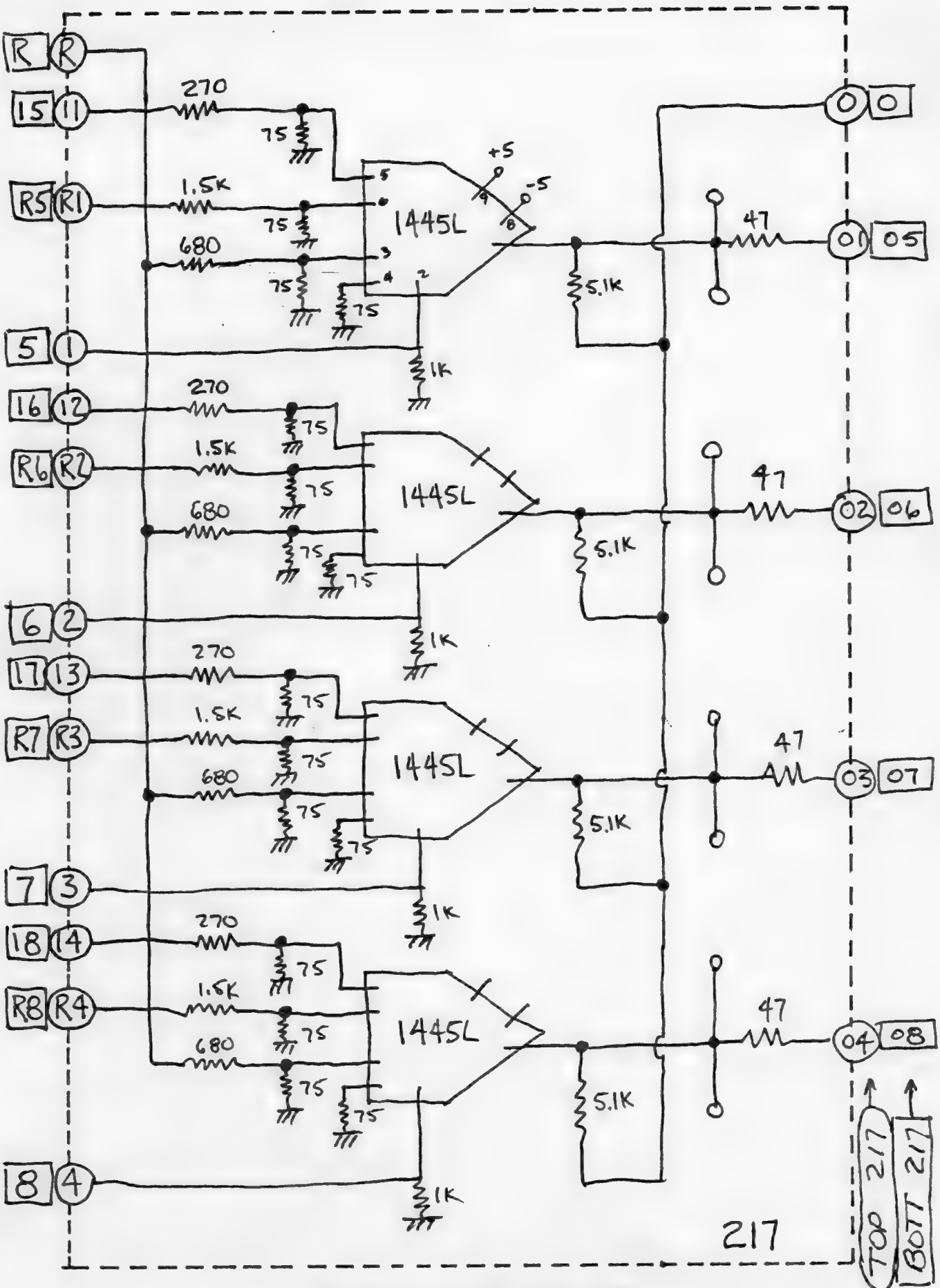


AMP. CLASS.

1-76



AMPLITUDE CLASSIFIER 1-76



MULTIPLIER BOARD

TOP OR BOTT.

AMP. CLASS.

1-76

OSCILLATOR

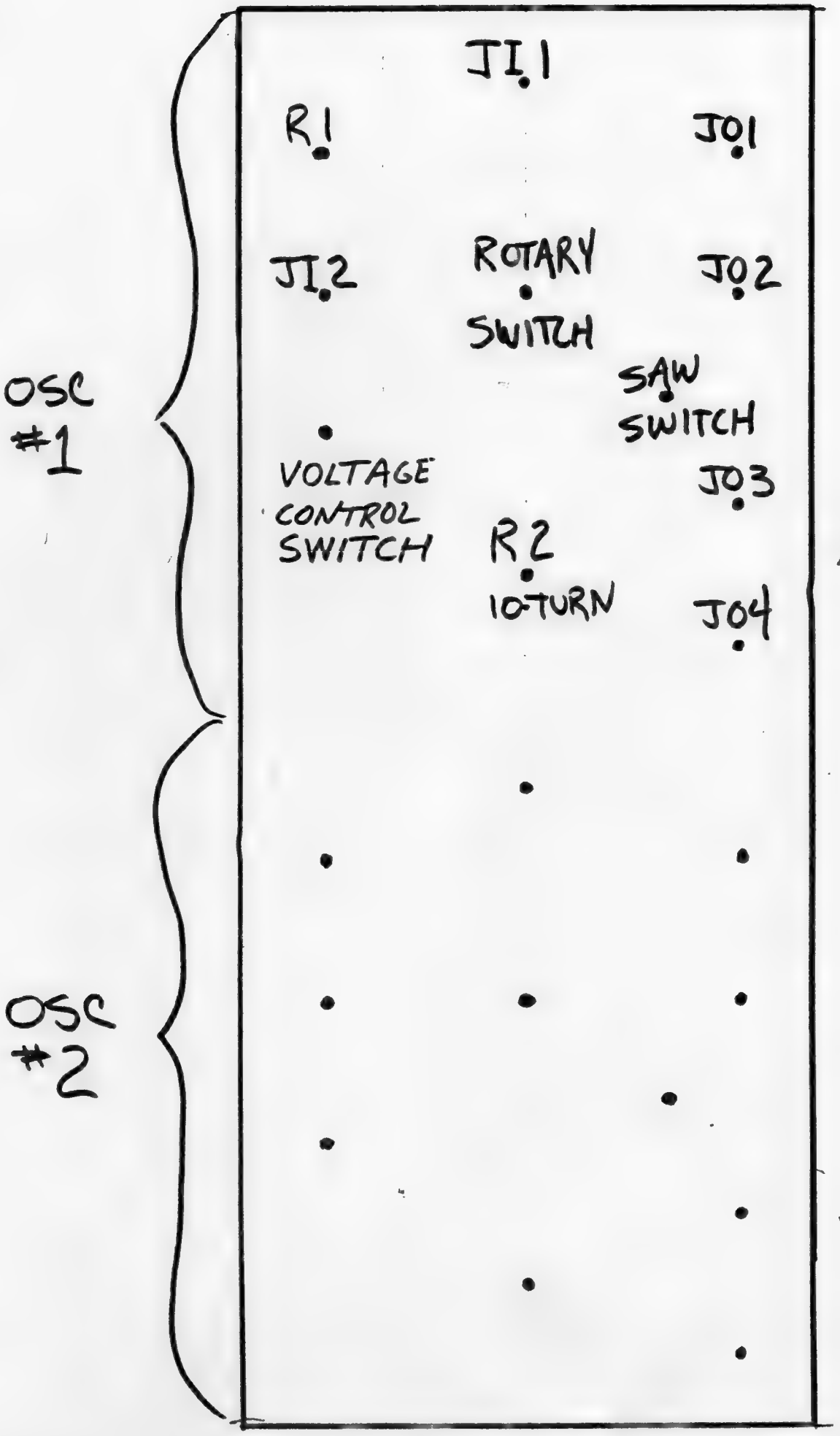
This module contains two oscillators that generates a sine wave output available at JO3, JO4 and a triangle wave output at JO1 and JO2. If the sawtooth switch is down instead of up, the triangle wave becomes a sawtooth and the sine wave becomes an "s" wave. The rotary switch sets the gross frequency range form 1/100 Hz. to ½ MHz. R2 is the continuous frequency adjustment. If the voltage control switch is up, a signal inputed to JI2 will control the frequence of the oscillator in combination with R2. With the switch down the voltage control is disabled but the oscillator is more stable. A sync. level (4 volt) signal into JI1 will trigger the oscillator to stabilize patterns.

CIRCUIT DESCRIPTION

The 8038 is a complete voltage controlled oscillator whose frequency is controlled by resistance R2 and the voltage at pin 8. The 715 is a 10x amplifier and- in combination with the zener diode produces a controll voltage at pin 8.

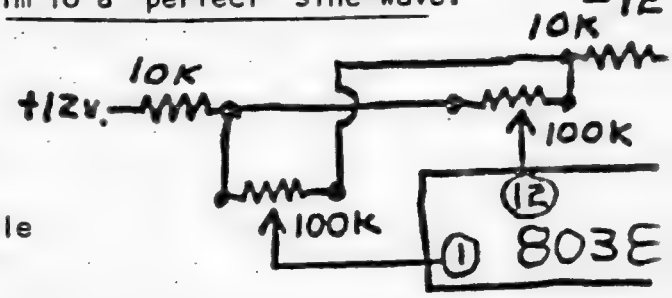
The trimmer associated with the input of the 715 should be adjusted so that the control voltage is centered within its range with 0 volts in. To do this, input a triangle wave to the voltage control input and adjust the trimmer until the voltage that makes the maximum frequency is as positive as the voltage that quenches the oscillator is negative.

The two transistors and zeners are used to trigger the oscillator. When a fast-falling signal is presented at the sync. input this turns the first transistor off which turns the second transistor on. This clamps the oscillator to the bottom of its output wave form.


JI.1
R1
JO1
JI.2
ROTARY
SWITCH
JO2
SAW
SWITCH
OSC
#1
VOLTAGE
CONTROL
SWITCH
JO3
R2
10-TURN
JO4
FRONT
FACE
OSC
#2
OSCILLATOR
9.75

1.) SINE-WAVE PURITY CONTROL:

Remove 82K resistor; and, add 100K trim-pots as shown in diagram. These 100K trim-pots correct sine-wave purity. You should be able to trim to a 'perfect' sine-wave.

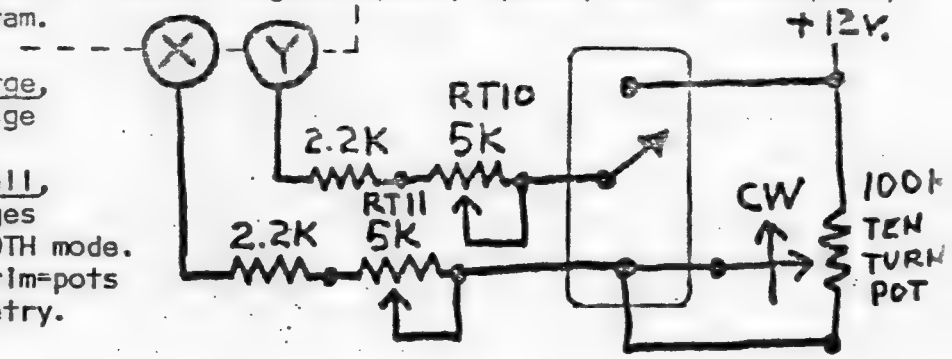


PROCEDURE-

A) Before supplying power to the module, center all trim-pots.
B) Set the oscillator at a middle freguency range, and display sine-wave on scope.
C) Tweek the trim-pots for highest amplitude possible (±1 volt) without creating any flats or peaks in the waveform; I.e. 'perfect' sine-wave.

2.) HIGH-FREQUENCY SYMETRY CONTROL:

R10 and R11 maybe replaced by a series combination of 2.2K resistor and a 5K trim-pot. This series combination (RT10 and RT11) correct high-frequency symetry and low-frequency quenching of waveform; see diagram.



If both trim-pots are too large, the high-frequency end of each range will be lower than optimum.

If both trim-pots are too small, the low-frequency end in some ranges may quench, particularly in SAWTOOTH mode.

The difference between the trim-pots determines the high-frequency symetry.

PROCEDURE-

A) All trim-pots should have been centered in above procedure, before supplying power; if, you didn't you might have blown the 8038...!
B) Turn 10-turn pot to extreme left (lowest freq.); check to make sure that no range quenc in sawtooth mode. If quenching happens in any range, tweek trim-pot to get rid of it...
C) Turn 10-turn pot to extreme right (highest-freq.); check to make sure that in a higher frequency range you still have good symetry in triangle mode. If you don't have good triar symetry, tweek trim-pot to get it...

GO BACK AND CHECK FOR SAWTOOTH QUENCHING...

D) To maximize high-frequency in ranges, decrease both trim-pots equally and go-to-step B). If oscillator quenches at low-frequencies, back up some; I.e. increase resistance, go-to step C). Stop.

NOTE:

These trim-pots will have to be outboarded on a perf-board and attached to card support fr of the module. Leave enough lead length on the trim-pots so it can be gotten out of the w for servicing the cards...!

Some 8038 integrated circuits appear to behave better than others; you may want to try various 8038's, choosing the best behaved ones...!

DIFFERENTIATOR

The differentiator produces an output which is proportional to the rate of change of the input signal. Fast rates of change correspond to edges in a picture and are preferentially amplified by the module.

JI6 amplifies only the sharpest edges...
JI5 amplifies the sharpest edges and slightly softer edges...
JI4, JI3 and JI2 amplify progressively softer and softer edges until by JI1 almost all of the whole picture is amplified.

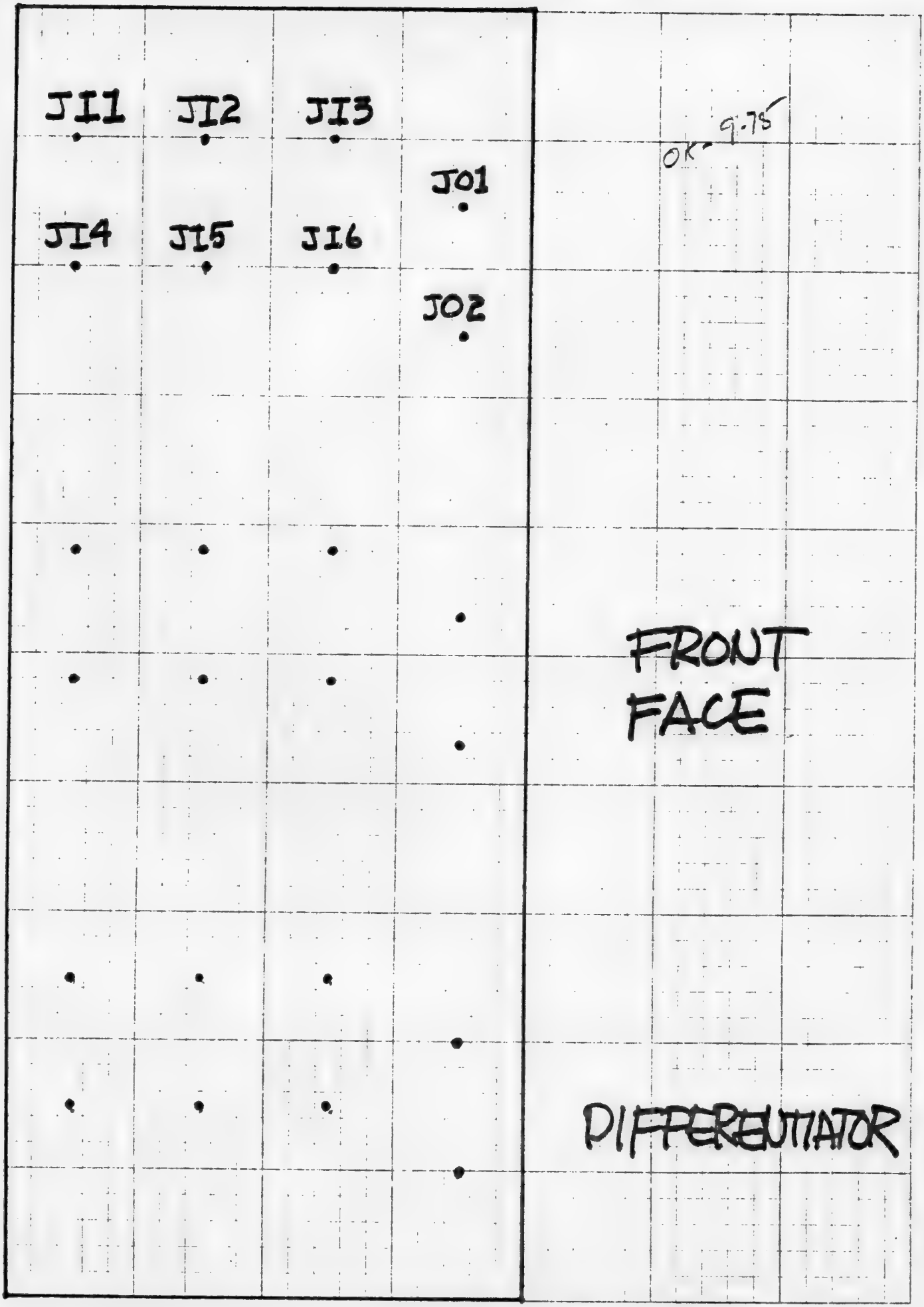
There are three electrical modules in one chassis box. One diagram is supplied, so replicate work three times. Remember to buss (connect) +12, -12 and ground from the center board to the upper and lower boards; soldering directly to the foil or connecting corresponding bypass capacitors is convenient.

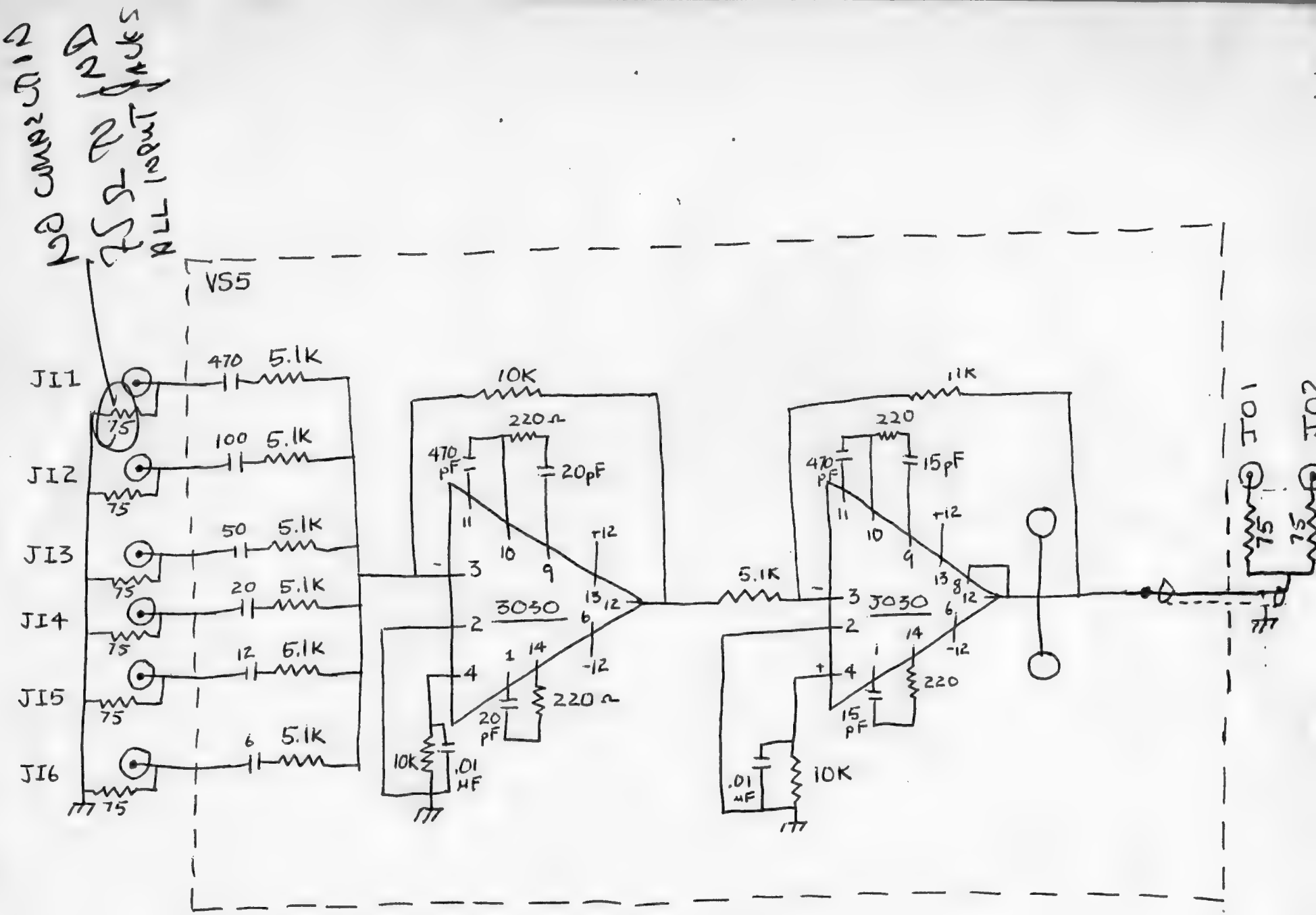
TEST STUFF:

The module should amplify high frequency (greater than 20 kHz) sine waves with greater gain than lower frequency sine waves. The sine waves should be undistorted.

Square waves should be differentiated; that is, there should be a positive spike associated with the rising edge of the square wave, and a negative spike associated with the falling edge of the square wave.

No input should result in 0 volts output + or - .05 volts.


JI1
JI2
JI3
JO1
JI4
JI5
JI6
JO2
OK - 9.75
FRONT FACE
DIFFERENTIATOR



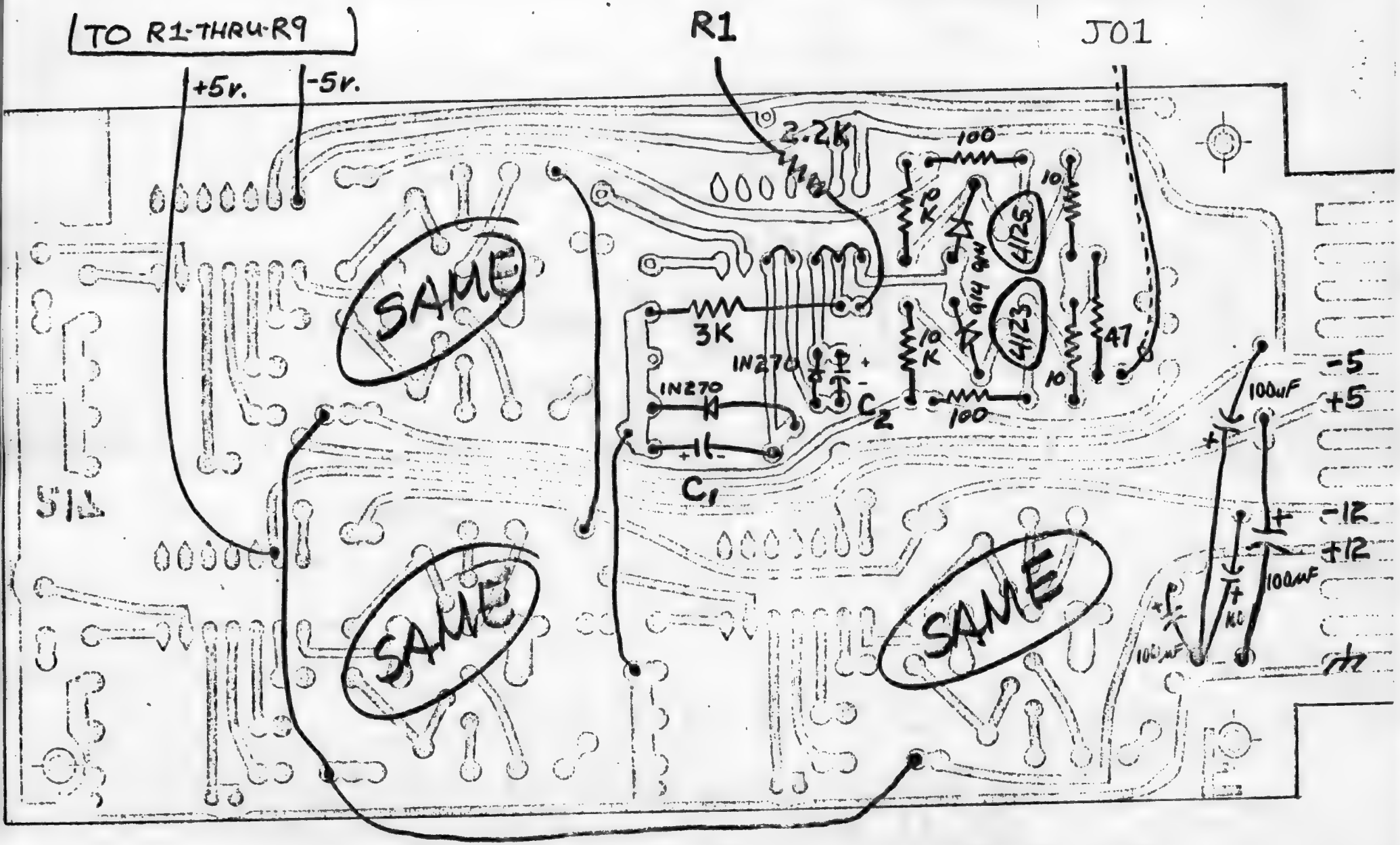
DIFFERENTIATOR 9

REFERENCE MODULE:

The Reference module produces a constant voltage proportional to front panel knob position. It uses 2¼ #217 printed circuit boards; save other 3/4 of board for making 3-D Joystick later...

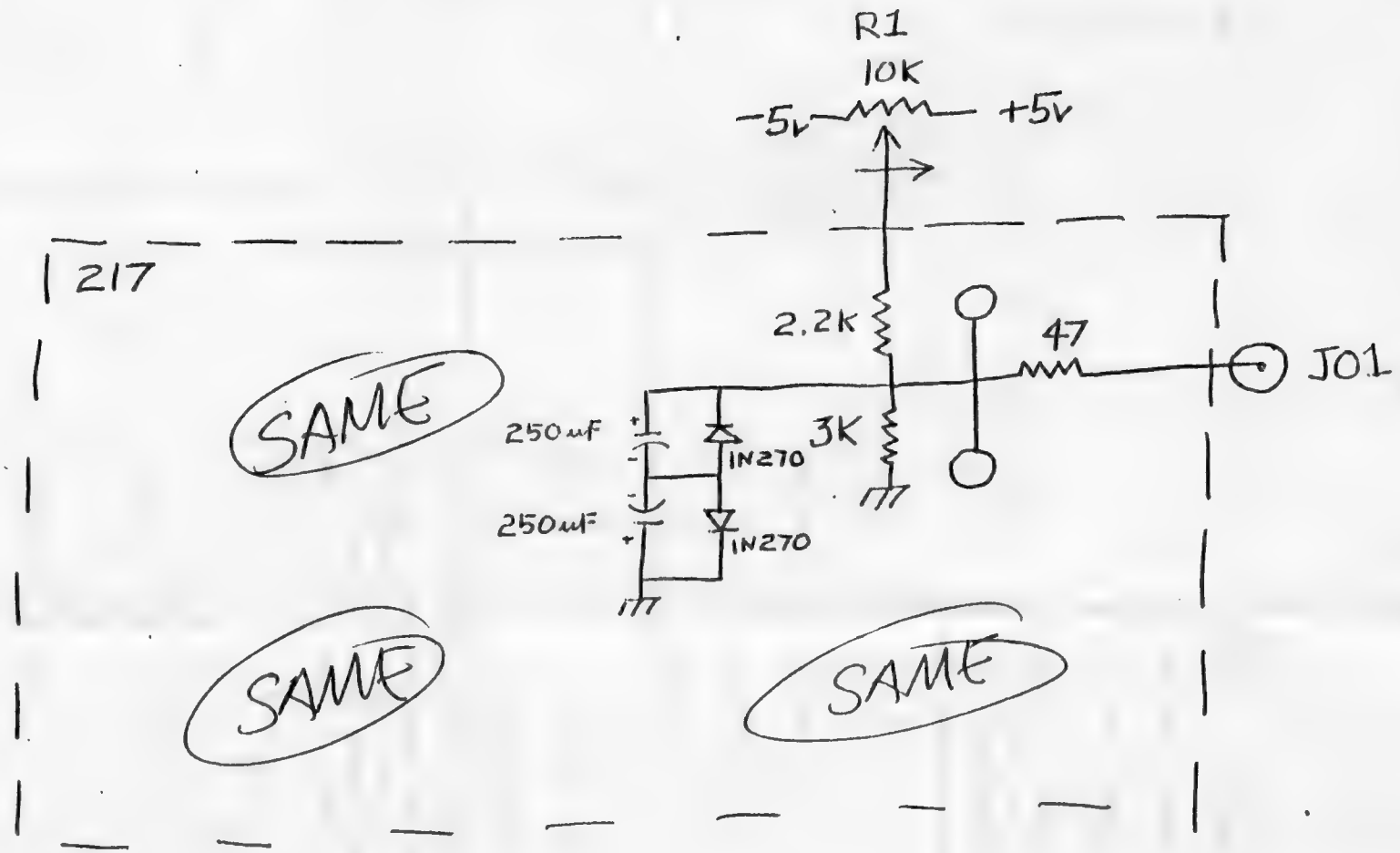
Joystick and slide pot inputs could be created in analogous manner. The value of input resistor, R1 through R9, is not critical; for instance if 5K ohm pots in joysticks are available, use them.

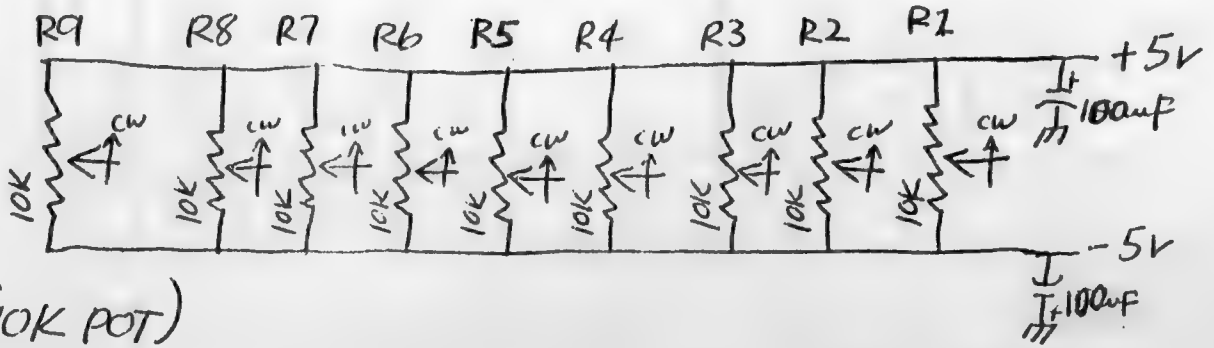
Capacitors C_1, C_2, are used to filter out noise. 100uF is the minimum and does not affect the feel much. Dan chose 250uF and Phil chose 1000uF; 1000uF is very 'slushy'.



CAPACITORS C_1, C_2, MAY BE ANY VALUE BETWEEN 100uf — 1000uf.

REFERENCE





FRONT FACE (10K POT) WIRING

REFERENCE

SYNC STRIPPER and CAMERA INPUT

This module performs several related utility functions.

A video signal is inputted to JI1; this signal is clamped and sync suppressed and is available at JO1, JO2, JO3 and JO4. This part is identical to one-third of the INPUT module except the composite sync is generated internally (consult INPUT module documentation for explanation).

In addition, the video signal inputted at JI1 is separated from the sync information by the sync strip card. The vertical sync is filtered and amplified by the vertical filter-amp and distributed to output jacks.

Similiarly, the horizontal sync information is filtered and amplified and distributed to output jacks.

Burst flag and blanking information is regenerated from the horizontal and vertical sync and distributed to output jacks.

Vertical sync (-4v.) is available at JO13, JO14 and at pin#2 of the EIAJ (6-pin) camera connectors.

Horizontal sync (-4v.) is available at JO9, JO10 and at pin#5 of the EIAJ (6-pin) camera connectors.

Blanking is available at JO11 and JO12. Burst is available at JO5 and JO6

The video signal (from the camera) with composite sync is made available at the BNC connector above the corresponding EIAJ (6-pin) camera connectors.

When this module is used, the sync for the IP is stripped from the video signal inputted to JI1. If a camera is used for this purpose it should of course not be be sunk to the IP; but must be internally sunk or sunk from a non-IP source.

TEST STUFF:

R2 and R3 should be adjusted the same as R1 and R2 in the INPUT module.
The trimmer on the vertical filter amp should be adjusted so the vertical signal out is the same length as the vertical sync present in the original signal.

The trimmer on the horizontal filter amp should be adjusted so the horizontal signal out is the same as the horizontal sync in the original signal. (NOTE: these adjustments are hard to make, but are not very critical in timing).

R4, front panel associated with the sync stripper, should be adjusted to minimize any jitter in output picture.

The blanking and burst amp is a set of three identical circuits except for the timing capacitors. Referring to the schematic diagram, the first half of the 9602 sets a delay time to the pulse and the second half times the pulse.

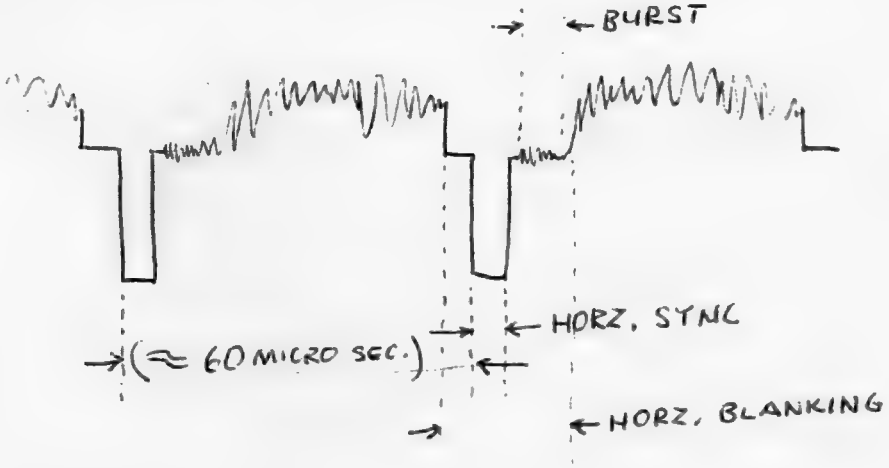
In the case of the burst flag R1T sets the delay from the beginning of the horizontal sync pulse to the beginning of the burst flag, and R2T determines the length of the burst flag.

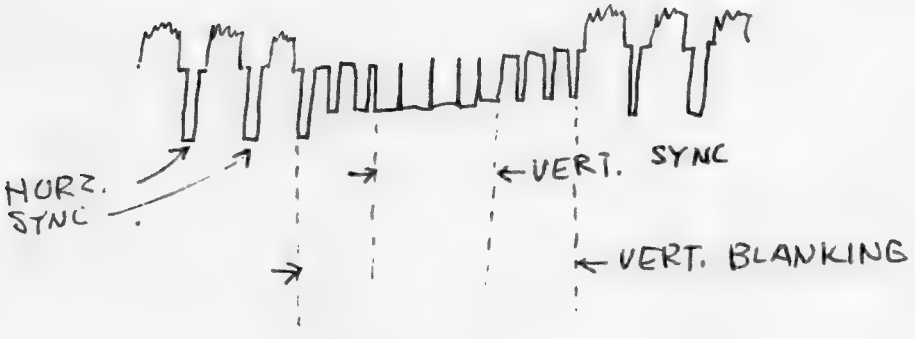
In blanking, R3T sets the delay from the beginning of the horizontal sync pulse to the beginning of the blanking pulse for the next horizontal line. This period is slightly less than on horizontal line. R4T sets the length of the blanking pulse.

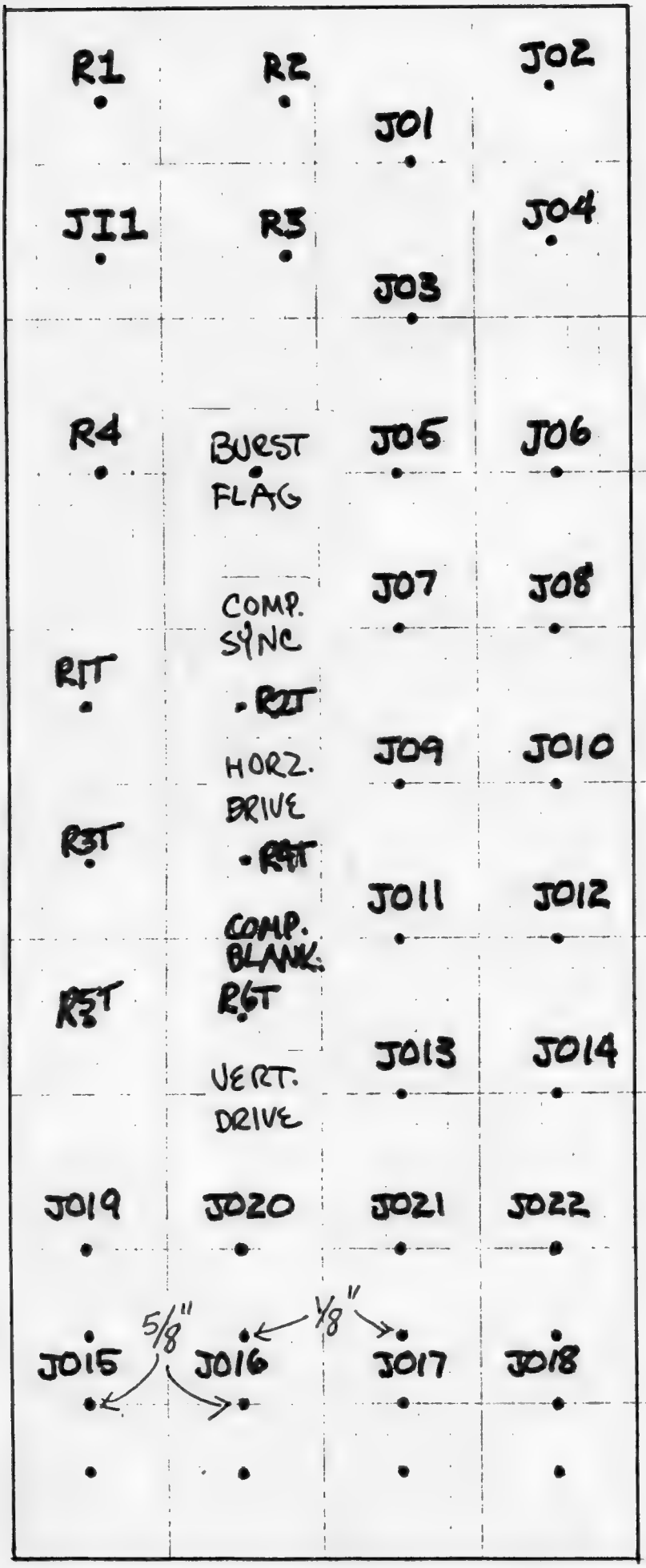
Vertical blanking is similiar with R5T setting the delay from the beginning of the vertical sync pulse to the beginning of the vertical blanking interval. R6T sets the length of the blanking interval.

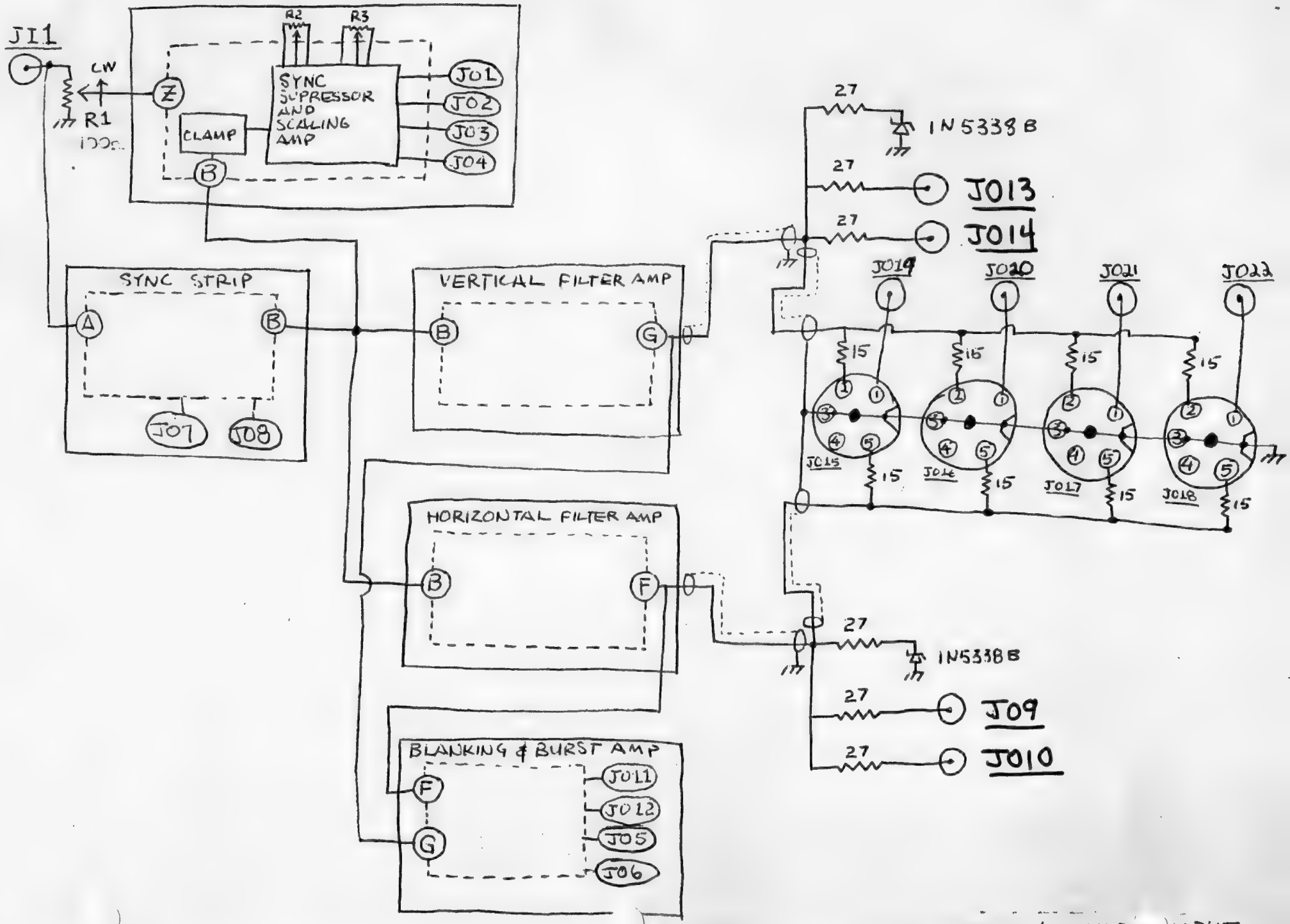
To adjust all of these, feed into the module a high quality video signal (from a clearly received broadcast station or from the color encoder in the IP driven by a high quality sync generator). Adjust the output pulses from the sync strip to be identical with the pulses from the standard source.

HINT: start with all pots turned nearly full clockwise (minimum resistance). If the resistance is too high the device stays on all the time and if the resistance is too small, pulse may be too short to be seen on an inexpensive osscilloscope. A dual-trace triggered osscilloscope is preferred but a single trace scope can be used.

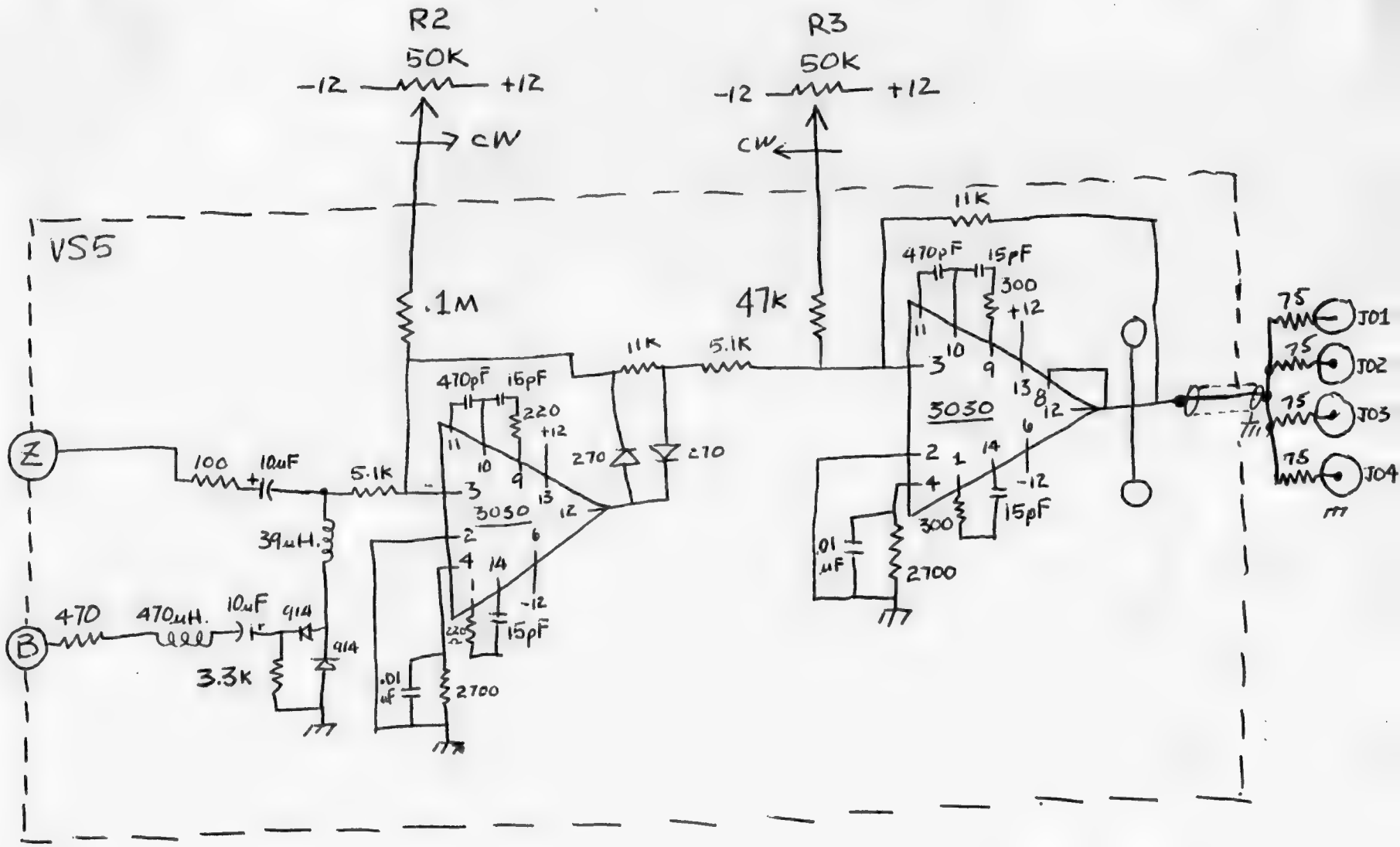




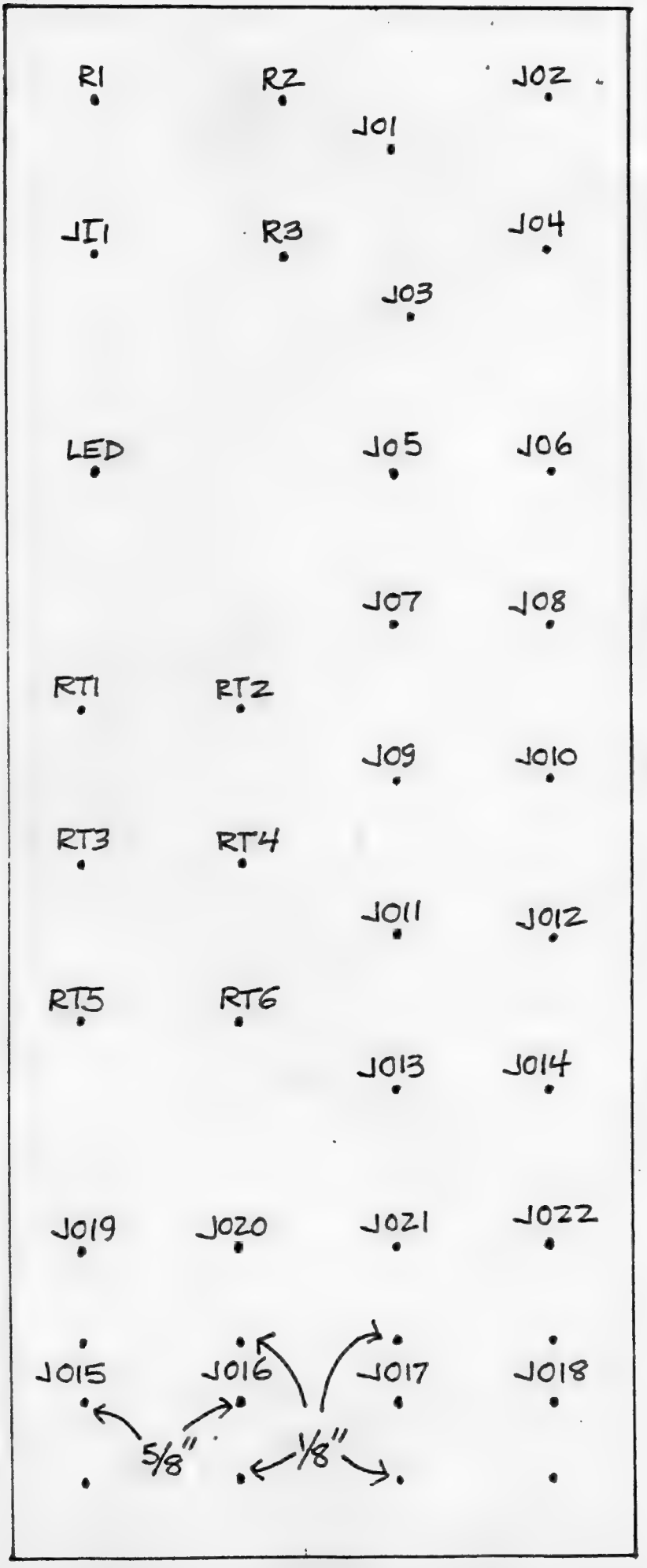

R1
R2
J02
J01
OK 9-75
JI1
R3
J04
J03
R4
BURST FLAG
J06
J06
J07
J08
COMP. SYNC
RIT
R2T
FRONT FACE
J09
J010
HORZ. DRIVE
R3T
R4T
J011
J012
COMP. BLANK.
R5T
R6T
J013
J014
VERT. DRIVE
J019
J020
J021
J022
5/8"
1/8"
J015
J016
J017
J018
SYNC STRIPPER & CAMERA INPUT

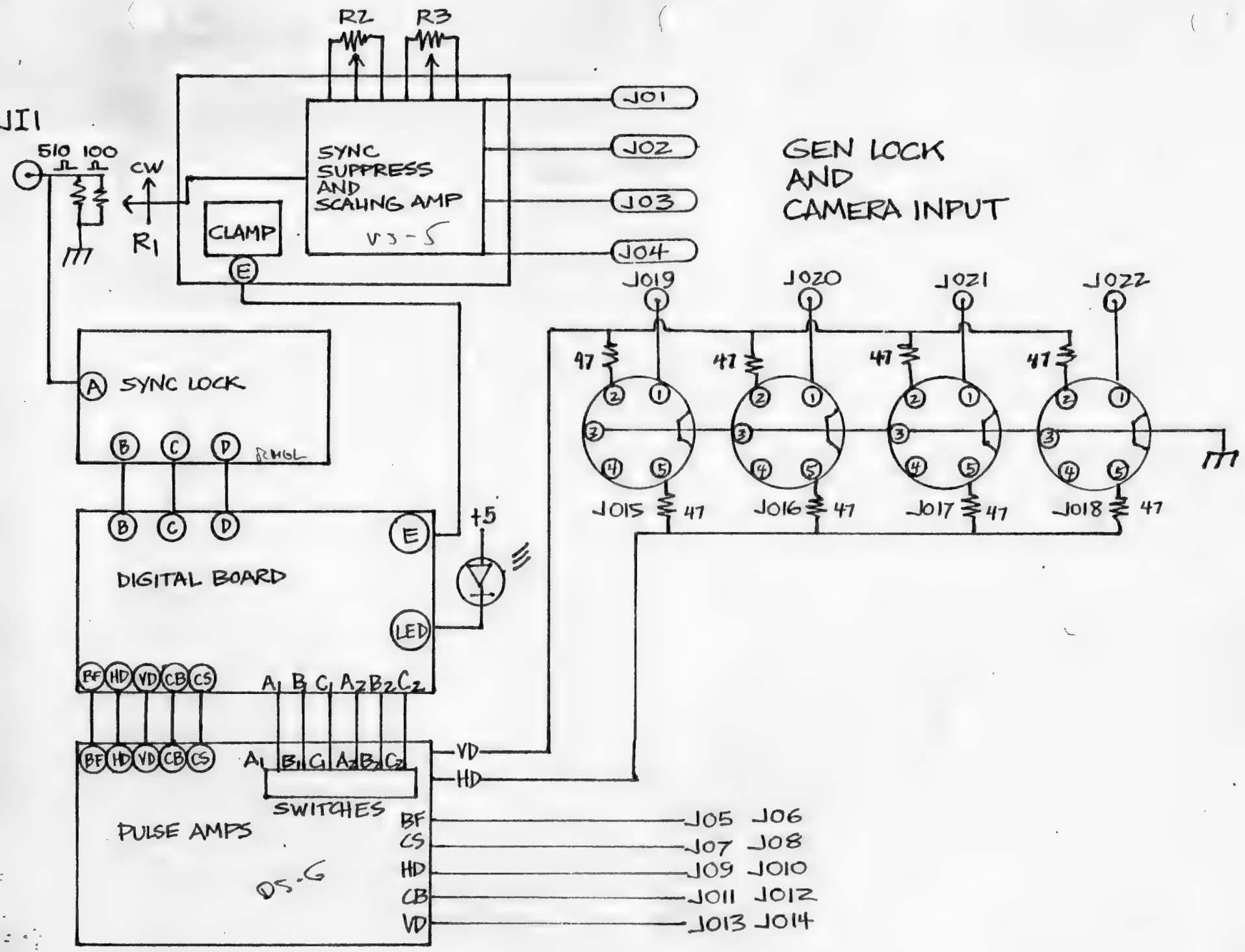

J11
CW
R1
100Ω
Z
B
R2
R3
SYNC SUPPRESSOR AND SCALING AMP
CLAMP
J01
J02
J03
J04
SYNC STRIP
A
B
J07
J08
VERTICAL FILTER AMP
B
G
HORIZONTAL FILTER AMP
B
F
BLANKING & BURST AMP
F
G
J11
J12
J05
J06
27
IN5338B
J013
J014
J019
J020
J021
J022
15
J015
J016
J017
J018
J09
J010
SYNC STRIPPER & CAMER INPUT

SYNC SUPRESSOR AND SCALING AMP



SYNC STRIPPER & CAMERA INPUT


R1
R2
J02
J01
FRONT FACE
J11
R3
J04
J03
LED
J05
J06
BURST FLAG
J07
J08
COMP SYNC
RT1
RT2
J09
J010
HORIZ DRIVE
RT3
RT4
J011
J012
COMP BLANK
RT5
RT6
J013
J014
VERT DRIVE
J019
J020
J021
J022
GEN LOCK AND
CAMERA INPUT
J015
J016
J017
J018
5/8"
1/8"


R2
R3
J1
510
100
CW
R1
CLAMP
SYNC SUPPRESS AND SCALING AMP
V3-5
J01
J02
J03
J04
GEN LOCK AND CAMERA INPUT
J019
J020
J021
J022
47
J015
J016
J017
J018
A
SYNC LOCK
B
C
D
E
DIGITAL BOARD
+5
LED
BF
HD
VD
CB
CS
A1 B1 C1 A2 B2 C2
SWITCHES
PULSE AMPS
J05 J06
J07 J08
J09 J010
J011 J012
J013 J014

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Richard Mandeberg

NORMOD
INDEX
NOT NECESSARY

GEN LOCK AND CAMERA INPUT

This module locks its output pulses to an external black and white, or color video signal inputted at JI1. In addition, the signal at JI1 is clamped, sync suppressed, and available at JO1 - JO4. This latter process is identical to one third of the INPUT module, except that the clamp signal is generated internally (consult IP documentation for explanation).

JO5 - JO14 are various synchronization and drive pulses at -4 volts into 75 ohms.

JO19 - JO22 are video signal outputs from cameras connected to the EIA-J 6 pin connectors.

The front panel LED indicates when the gen-lock is locked to an external source. Light ON means that lock is present, light OFF means the module is not locked. Outputted sync is only stable for recording when the light is ON.

CIRCUIT DESCRIPTION

Video at JI1 goes to the Sync Lock board which contains a TBA920 integrated circuit. The TBA920 is a combination sync strip and horizontal phase locked loop oscillator. Stripped sync is converted to proper TTL digital voltage levels by one half of the 319 comparator. Sync is also filtered to pick off vertical. This resultant vertical trigger pulse is buffered by the other half of the 319, and used to initiate the vertical timing process on the digital board. The horizontal oscillator locks in both phase and frequency to an external video source. R1 controls the free running frequency (no video input) of the horizontal oscillator. R2 controls the phase of the oscillator when locked (video present). The leading edge of the horzontal oscillator pulse is usually set to coincide with the beginning of horizontal blanking.

The digital board has basically three sections. The horizontal timers (74123's) are driven by the horizontal oscillator pulses. They are set up so that all pulses during the horizontal blanking interval may be retimed and rephased. The vertical section is controlled by counters (74163's) and associated NAND gates and flip-flops. DIP switches A1, B1, C1, control the position of vertical blanking and drive. Switches A2, B2, C2, control the length of vertical blanking. Using A2 - C2, VB may be set anywhere from 17 to 24 horizontal lines long. Other

NAND gates on the board are used for sync recombination, and to detect when the device is locked properly to an external source.

SET UP

A dual trace oscilloscope is desirable, but not absolutely necessary. One vertical channel is connected to a high quality composite video signal (like the IP). The oscilloscope must be triggered from this source, either externally, or by channel selection. Set the scope to display several lines of video.

Follow the steps in the order given. Each step must be set up correctly before continuing to the next.

1. Using the other vertical scope channel, attach an oscilloscope probe to line B of the sync lock board. With NO VIDEO input adjust R1 so that the horizontal oscillator rate is approximately the same as that of the video.

2. With a video input at JI1, adjust R2 so that the phase of the horizontal oscillator pulse lines up with the beginning of horizontal blanking. This adjustment is a master horizontal phase control in that all pulses during the horizontal blaking interval are timed in relation to the leading edge of the horizontal oscillator pulse. When you change R2, all horizontal sync components will change phase accordingly.

3. Replace the scope probe with a 75 ohm line attached to composite blanking. Adjust RT5 for the proper length of horzontal blanking.

4. Looking at the output of horizontal drive, adjust RT6 for the proper length of HD.

5. Using the composite sync output, adjust RT3 for horizontal sync phase, and RT4 for sync length.

6. RT1 controls the phase position of burst flag, while RT2 controls its length. Burst flag is timed in relation to the leading edge of horizontal sync. Phase changes in sync will cause concurrent phase changes in burst flag.

7. Trigger the scope to display several fields of video. Using the vertical drive output, set DIP swithes A1,B1, and C1, to position VD at the beginning of the vertical blanking interval. The three switches have eight different possible position combinations. If VD is at best offset by one half line of video (advanced or delayed) from the beginning of vertical blanking, you are looking at the odd (B) field. In this case, set VD so that it is

advanced by one half line.

8. Attach the 75 ohm line to the composite blanking output. Vertical blanking should have the same phase as vertical drive. Adjust switches A2, B2, and C2, for the correct length of VB. 22 lines should be the maximum setting.

CONSTRUCTION

On the digital board, some wires are soldered from point to point, others are wire wrapped. Follow both the wire wrap list, and the pictorial. Remember to cut the foil, and jump ground to the outside bus, where noted.

All circuit boards, except the VS5 are mounted of 1" standoff mounting posts. VS5 is mounted at the top of the module, RMGL board in the middle, and the DS6 at the bottom. Mount the digital board behind the DS6, and RMGL boards. Input/output wires on the digital board should be kept to one edge, so that the board may be swung back for replacement of IC's, troubleshooting, etc.

Line E from the digital board runs to point JI2 on the VS5 board. Reverse the polarity of the 10uf cap. which is in series with the 470uh choke and the 1N914 diode.

On the Pulse Amp board (DS6), mount the 7808 voltage regulator to the heat sink, and then to the board itself with a 4x40 screw.

Remember to bus ground and the appropriate power to the circuit boards. +5 volts must also be run to the front panel for the LED, and the trimmers.

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ADDENDUM TO THE GEN LOCK

In its initial design, the Gen Lock misplaces the leading edge of vertical blanking by one half line during the odd field. This circuit addition will fix that problem, and reestablish proper interlace to composite blanking. Vertical sync information is unchanged by this addition, as sync was already correctly interlaced in the previous design.

This addendum is useful to people who anticipate that much of their work will be time base corrected, or that they will be working often in a broadcast environment. The earlier design will work fine with all non-broadcast equipment, and its use does not preclude the ability to time base correct your videotapes.

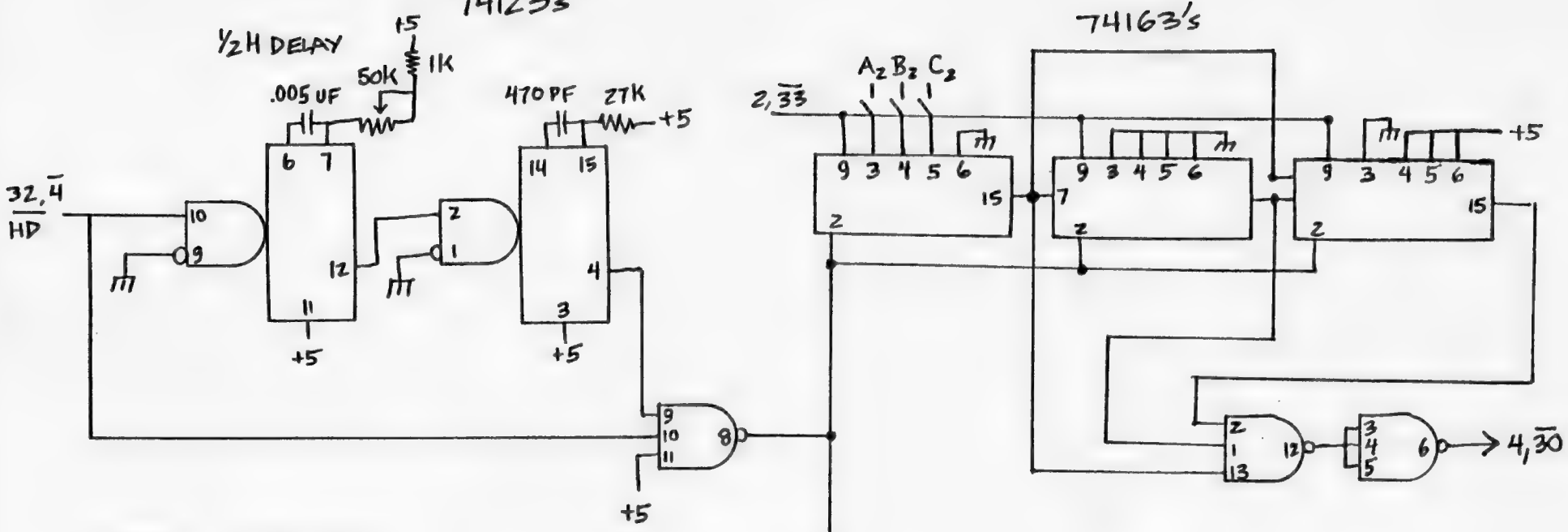
NOTE: The addition of this circuit makes the construction of the Gen Lock more complex and difficult. If you don't understand how to put it in, use the original design. The module will work fine, and you can add the additional circuit later.

CONSTRUCTION

Build the circuit on perf board, wire wrapping the connections. Mount it above the digital board. Remember to bus ground and +5 volts to the board, and bypass +5 to ground with a .1uf cap. every few IC's. Mount the 74123 and the 50k trimmer near the rear of board, with the trimmer adjust facing back. Drill a hole in the back panel in the appropriate place for the 1/2 H adjustment. On the main digital board remove the 74163 which is in line with the 74123's, and remove the 74163 below it also. Do not wire wrap wires associated with these two IC's.

SET UP

Attach an oscilloscope probe to pin 8 of the 7410. Display it, and a high quality video signal (also inputted to the Gen Lock) on both channels of the scope. Trigger the scope to show the beginning of the vertical blanking interval, including equalization pulses and sync. Adjusting the 50k trimmer will change the phase of the 1/2 line pulse. Using every other equalization pulse as a guide, adjust these pulses so that their leading edge is coincident, or slightly ahead of the leading edge of the equalization pulses.



74123 PIN 16. +5
PIN 8. m

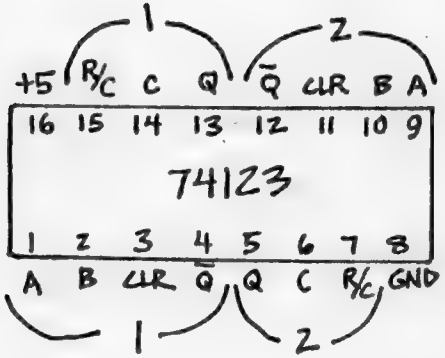
74163 PIN 16. +5
PIN 8. m
PIN 1. +5
ALL UNUSED PINS 7, 10. +5

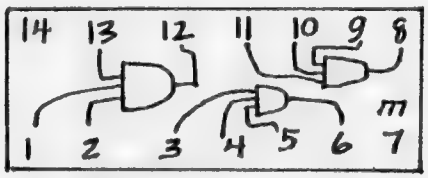
7410 PIN 14. +5
PIN 7. m

ON DIGITAL BOARD
MODIFY TO:

+5 22, 21, 32, 21,
31, 21

GND 34, 21, 33, 21





7410

GEN-LOCK MODIFICATION 3/79

INPUT

The input module suppresses the sync and clamps the signal coming from the camera, thus preparing any standard video input for the IP.

The video signal is inputted at JI1 and composite sync (-4v.) is inputted at JI2.

There are three electrical modules in the chassis box, so replicate work three times. There is only one JI2 in the chassis box and its terminal should be connected to the same spot on all three cards. Remember to buss (connect) +12 and -12 and ground from center card to top and bottom card. Also buss +12 and -12 to front panel for R1(s) and R2(s); take from center card.

TEST STUFF:

R1 is adjusted untill most of the sync is suppressed but blacks are not clipped. (An osscilloscope is necessary.) R2 is adjusted until the video signal is symetrical, about 0 volts and has a magnitude of approximately 1 volt peak-to-peak into a 75 ohm load.

The output is available at JO1, JO2, JO3 and JO4.

NOTE: these adjustments may have to retuned, off and on, for different video sources.

SYNC GENERATOR

This module generates full NTSC color sync conforming to RS 170 EIA after trimming the master osscillator. The sync generator should stay well within the broadcast standard.

All outputs are -4v. into 75 ohm except the 14 MHZ. (JO13) which is an open collector TTL. JO13 is not used except for work with digital computers.

JI1 horizontal reset and JI2 vertical reset are not implemented in full.

The sync generator requires starting pulses which are provided by capacitors associated with JI1 and JI2. Time must be allotted after power-down before power-up (at least 30 seconds) to assure proper starting of sync generator.

Master osscillator trim:
Adjust the master osscillator frequency to 14.318180 MHZ. A convenient way to do this is to run a lead from horizontal drive and wrap it (still fully insulated) around the antennae of a TV receiver. Tune the receiver to a station on feed from a major network (in color). You will notice two vertical lines or one vertical bar drifting across the screen. Adjust the master osscillator with a long insulated screwdriver through the access hole in the front panel of module until vertical lines do not drift.

4-D56

10K Ten Turn Trimmers

COLOR ENCODER

This module generates a N.T.S.C. compatible color video signal. The front panel switch selects between an internal color bar generator, and the front panel Red, Green, and Blue inputs. Its inputs and outputs are;

JI1 3.58 MHz Color Carrier (1-2 volts p-p) SUB CARRIER
JI2 Burst Flag
JI3 Composite Sync
JI4 Horizontal Drive (not used)
JI5 Composite Blanking
JI6 Vertical Drive (not used)
JI7 Red (+.5 to -.5 volts)
JI8 Green " "
JI9 Blue " "

JO1 N.T.S.C. video
JO2 " "
JO3 " "

The Luminance Board combines Red, Green, and Blue to form the luminance component of the video signal. The inverted (-Y) form is used within the Color Encoder, and sent to the R-Y, B-Y, and Chroma Modulator Boards. Blanking and sync are also inserted on the Luminance Board.

The R-Y, and B-Y Boards accept red, and blue respectively, and form the color difference signals. Each signal is low pass filtered to help bandwidth limit the resultant chroma signal. Burst Flag is used to effect proper burst height and hue adjustment.

The Chroma Modulator Board generates chroma from the color difference signals, and combines it with the luminance component. The Bar Generator Board serves two functions. Controlled by the front panel switch, it generates the proper red, green, and blue signals for making color bars. Composite blanking is also converted from an EIA type pulse to a TTL level signal and sent to other boards within the module.

Mount the Bar Generator, and B-Y Boards in the top of the module. R-Y, and Chroma Modulator Boards go on the bottom, with the Luminance Board in the middle.

Carrier balance and white balance may drift during warm up. Make all internal adjustments after the IP has come up to temperature. In a broadcast environment, a proc. amp. may be necessary to prevent accidental over chroma modulation.

Richard Mandeberg 6/80

SET-UP

Set-up should be done only after the IP has warmed up for at least twenty to thirty minutes. You will need to know the proper gain and amplitude levels (either in I.R.E. units or voltages) for N.T.S.C. video. A vectorscope, if accessible, may be substituted in some of the steps.

1. Attach all inputs except for red, green, blue, and 3.58. Display one or two lines of output on the oscilloscope. Set all internal trimmers to center position.

2. Set the front panel switch in the bars position. Adjust RT10 and RT11 for the proper descending stairstep associated with the luminance component of color bars. Adjust RT1 (Y Gain), R4 (Pedestal), and R8 (Sync Height) for luminance amplitude, pedestal, and sync.

3. Attach the 3.58 input. Adjust RT2 and RT5 for minimum carrier leakage during blanking.

4. Turn R7, the front panel Chroma Gain to the full gain position. Switch SW to video. Adjust RT3 and RT6 for minimum carrier leakage during active video.

5. Switch back to bars. Adjust RT4 and RT7 for white balance.

6. Adjustment of the B-Y Gain (RT8) requires repeated tweaking of white balance and carrier leakage. RT8 is adjusted to give the proper chroma amplitude relationships between the different colors of color bars. Alternatively, it may be set by looking at the direct outputs of the R-Y, and B-Y Boards, and setting them for the correct gain relationship. Tweak RT8, and repeat steps 4, 5, and 6 until correct. Remember, RT3 and RT6 are adjusted with SW in the video mode.

7. With R7 still at full gain, adjust RT9 for 100% chroma.

8. Adjust R6 for burst height. Using a properly tuned monitor set R5 for the correct hue or phase of color bars.

9. In the video mode, with the encoder driven to white, the white balance may need slight adjustment.

PARTS

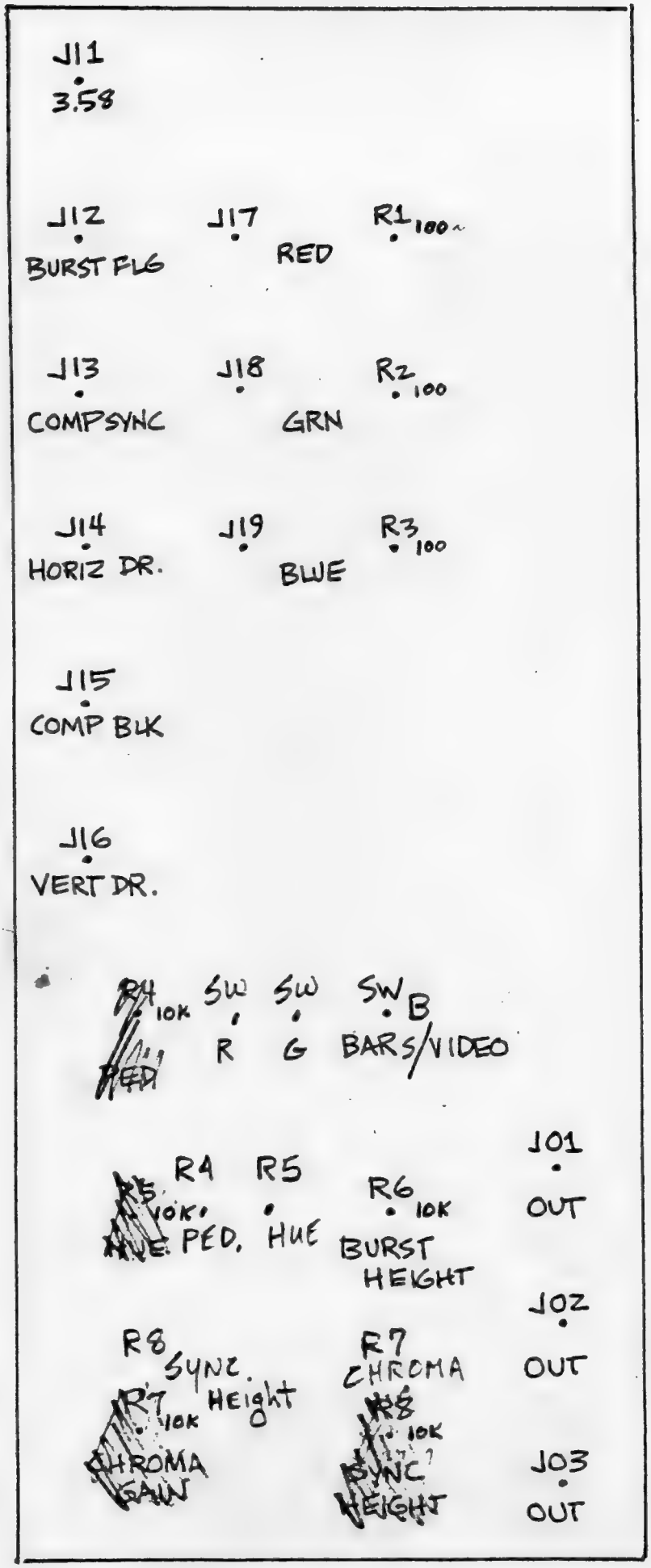
All parts are standard IP parts except;

LM1889N	Chroma Modulator	National
DM74LS14N	Hex Schmitt Inverter	National
DM74LS74N	Dual Flip Flop	National
LM555CN	Timer	National

MOD Chroma Modulator P.C. Board from E.C.I.

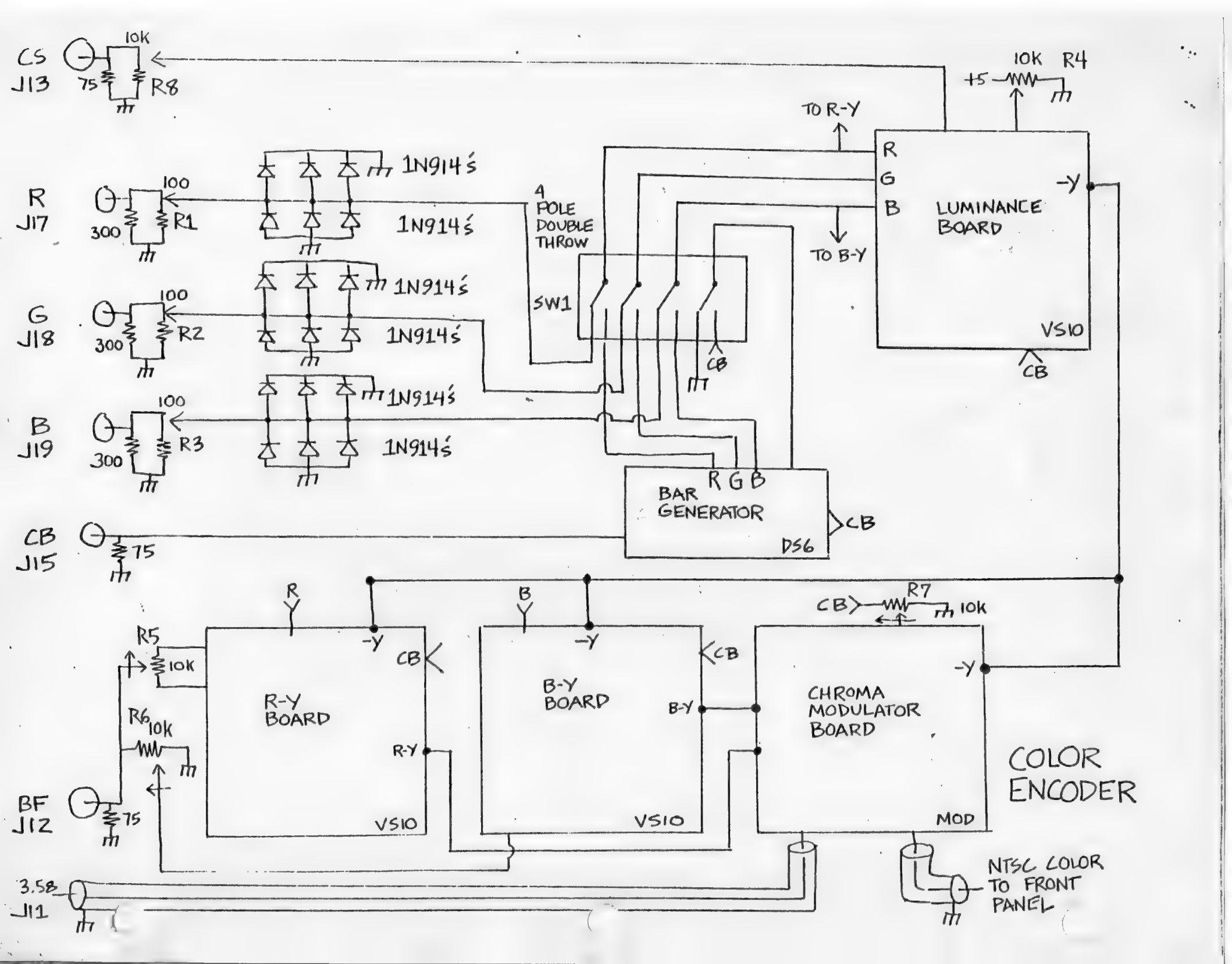
When # of moduals changes readjustment is necessary only on RT2, RT3, RT5, & RT6 (Carrier Balance & Carrier Null)

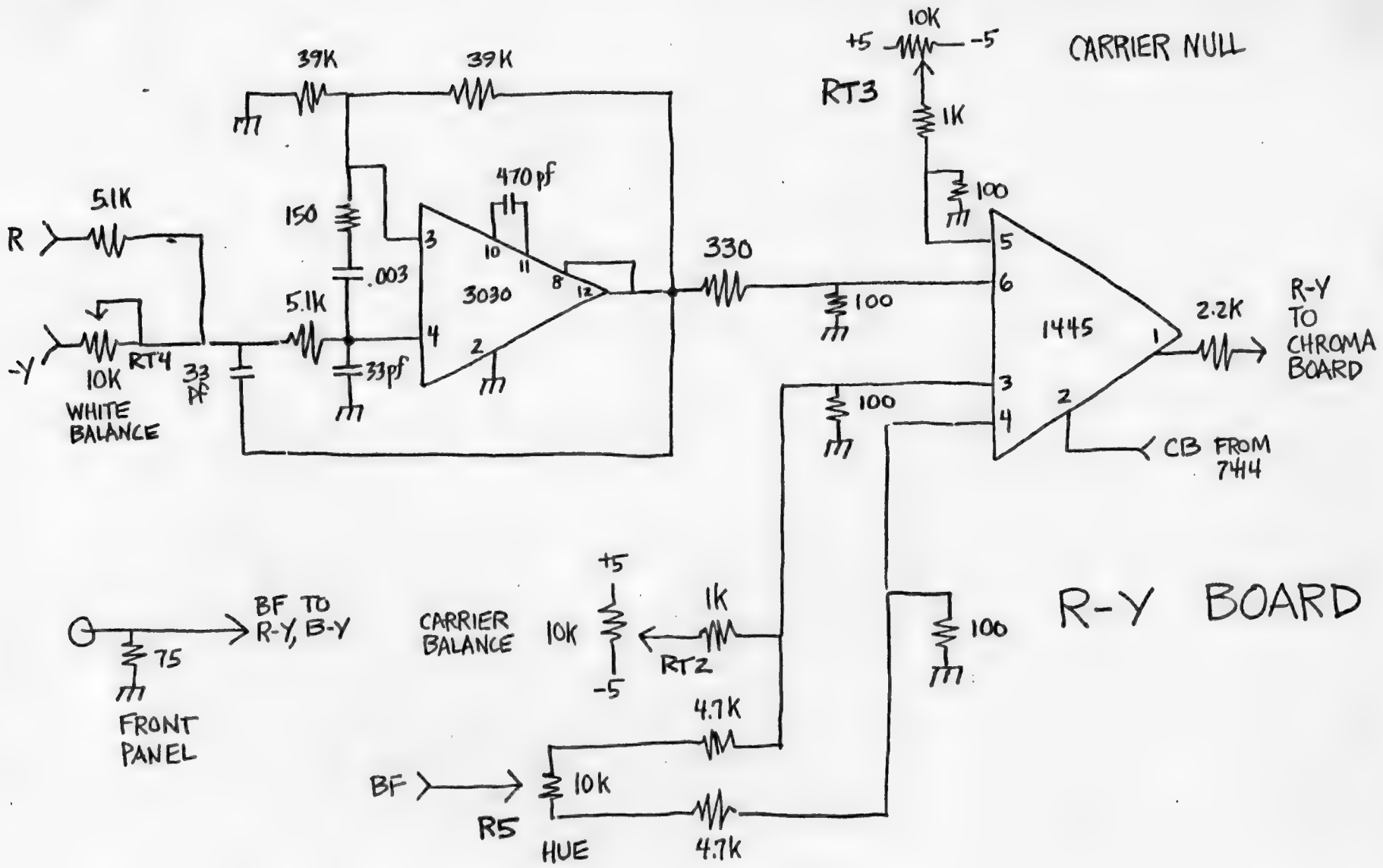
3



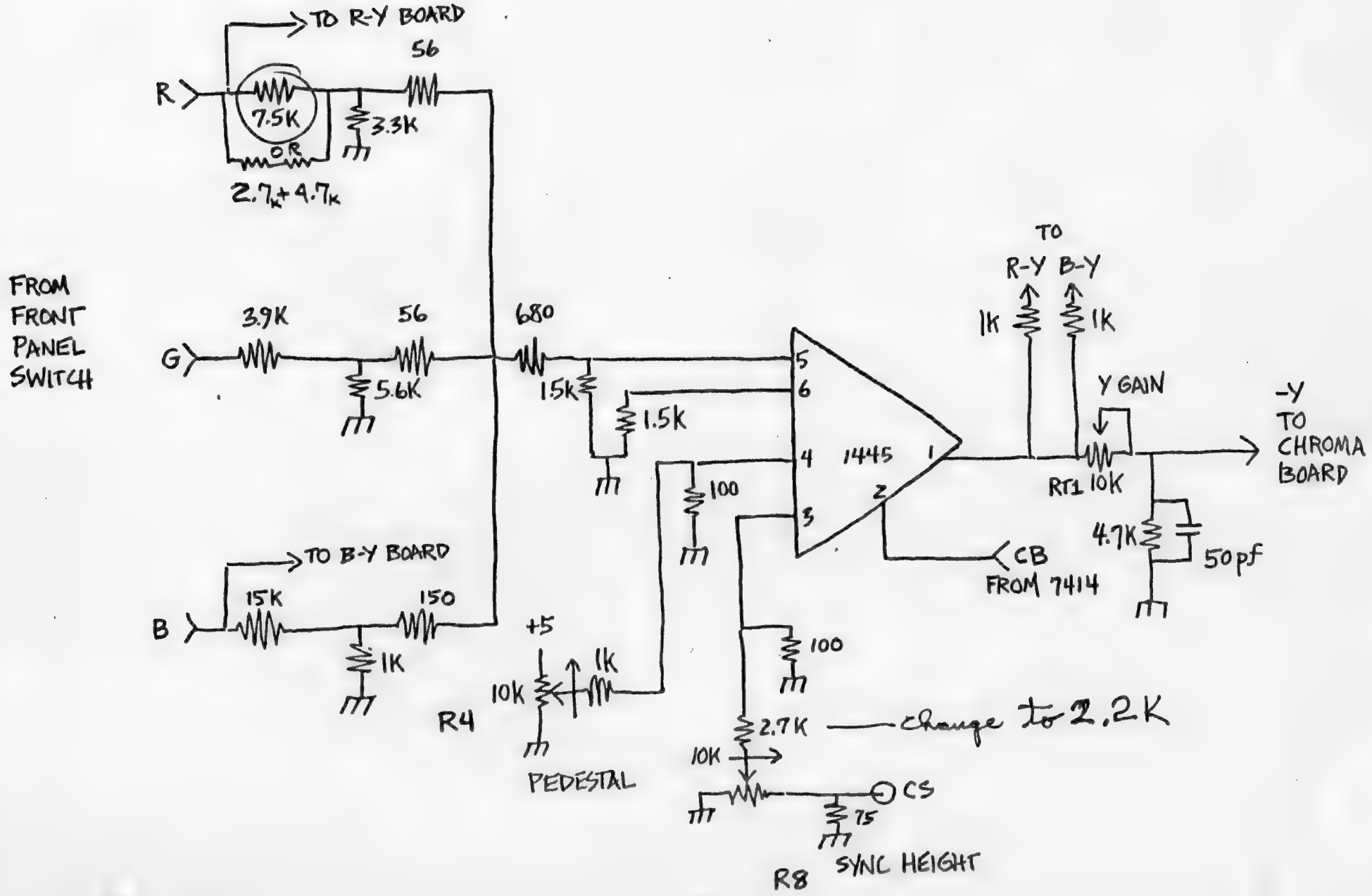
FRONT FACE

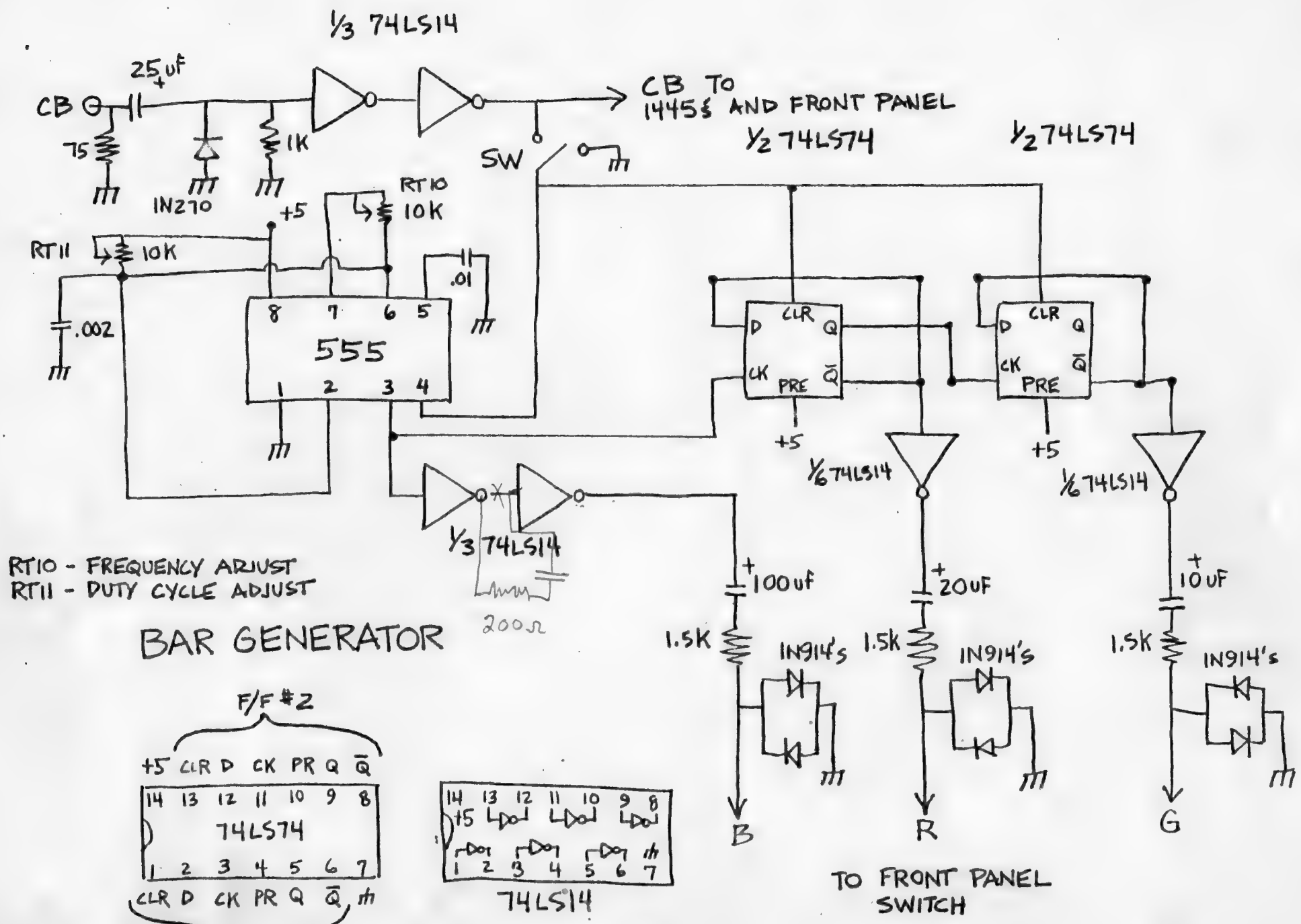
COLOR ENCODER


CS
J13
10K
75
R8
10K R4
+5
TO R-Y
R
G
B
LUMINANCE
BOARD
-Y
VS10
CB
TO B-Y
R
J17
100
300
R1
1N914's
1N914's
4
POLE
DOUBLE
THROW
SW1
G
J18
100
300
R2
1N914's
1N914's
B
J19
100
300
R3
1N914's
1N914's
CB
CB
J15
75
R G B
BAR
GENERATOR
DS6
CB
R
B
CB
R7
10K
R5
10K
R6
10K
R-Y
BOARD
-Y
CB
R-Y
VS10
B-Y
BOARD
-Y
CB
B-Y
VS10
CHROMA
MODULATOR
BOARD
-Y
MOD
BF
J12
75
3.58
J11
NTSC COLOR
TO FRONT
PANEL
COLOR
ENCODER

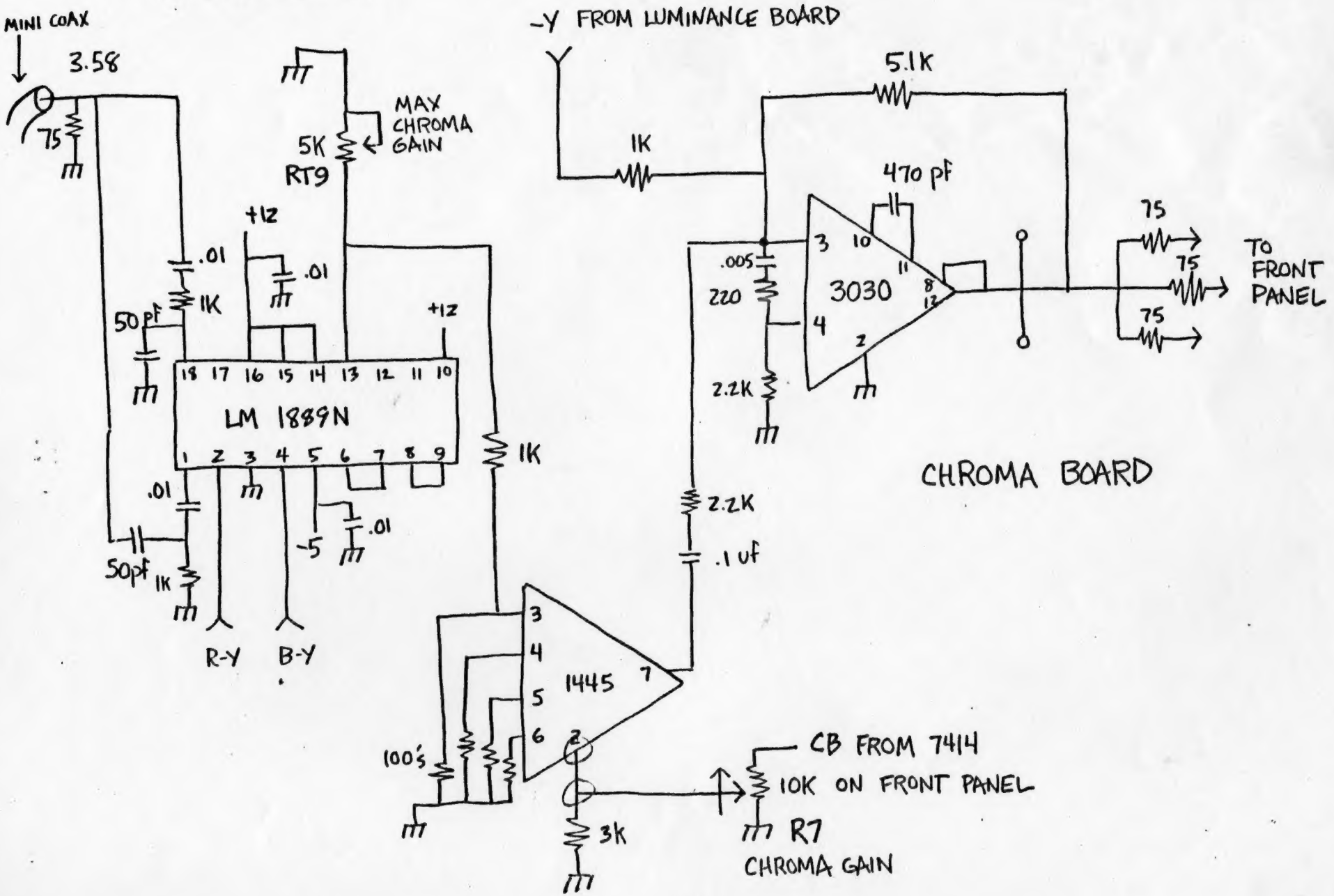

39K
39K
10K
+5
-5
CARRIER NULL
RT3
1K
100
5.1K
R
470 pf
150
.003
5.1K
3030
330
100
2.2K
R-Y
TO
CHROMA
BOARD
1445
-Y
RT4
10K
WHITE
BALANCE
33
PF
33pf
100
CB FROM
7414
BF TO
R-Y, B-Y
75
FRONT
PANEL
CARRIER
BALANCE
+5
10K
-5
1K
RT2
100
R-Y BOARD
4.7K
BF
10k
R5
HUE
4.7k

LUMINANCE BOARD




1/3 74LS14
25 uF
CB
75
IN270
1K
CB TO 1445 AND FRONT PANEL
SW
1/2 74LS74
1/2 74LS74
RT10
10K
+5
RT11
10K
.01
.002
8 7 6 5
555
1 2 3 4
CLR
D
Q
CK
PRE
Q̄
+5
+5
1/6 74LS14
1/6 74LS14
1/3 74LS14
200Ω
+
100 uF
+
20UF
+
10 UF
1.5K
IN914's
1.5K
IN914's
1.5K
IN914's
B
R
G
RT10 - FREQUENCY ADJUST
RT11 - DUTY CYCLE ADJUST
BAR GENERATOR
F/F #2
+5 CLR D CK PR Q Q̄
14 13 12 11 10 9 8
74LS74
1 2 3 4 5 6 7
CLR D CK PR Q Q̄
F/F #1
14 13 12 11 10 9 8
+5
1 2 3 4 5 6 7
74LS14
TO FRONT PANEL SWITCH

NOTE: USE SHIELDED CABLE
FOR 3.58 AND OUTPUT



POWER SUPPLY

The power supplies are purchased modules and should come with complete documentation; if not request from LAMDA.

In the IP, power supply regulation and high frequency transient response are critical. Substitution of other power supply modules is NOT recommended.

In each box all corresponding terminals of the 10 pin Jones connector are connected together.

The output of the power supplies are connected to the appropriate pin of one of the connectors.

In box one, the binding post terminals are connected to the appropriate 10 pin Jones.

A cable with two male Jones plugs and corresponding pins connected together is used to communicate power between the boxes.

One side of each box should be covered with perferated metal or screen to allow for ventilation. This side should never be blocked to prevent ventilation. DO NOT let transistors touch screen.

The 110 v. AC which powers the power supplies is the only potentially lethal voltage in the IP. BE CAREFUL AND WATCH YOUR FINGERS.

--Box one contains +12, -12 power supplies.
--Box two contains +5, -5, +14 power supplies.

NOTICE: --+14 volt power supply needed for Color Encoder only!
(not needed for black and white operation.)

AC PLUG SYSTEM

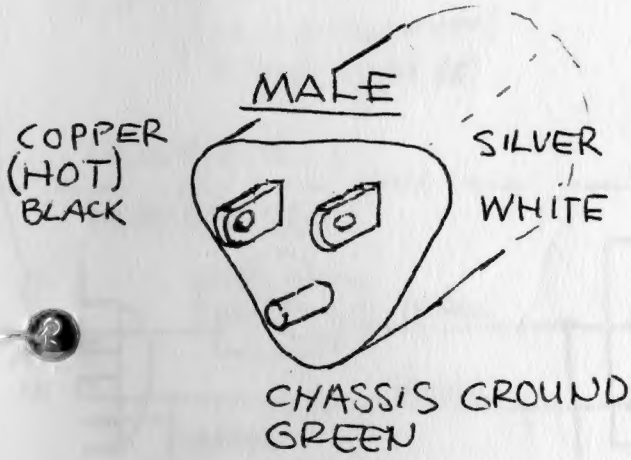
WATCH ALL OF THIS STUFF!!!

SOMEONES LIFE MAY DEPEND ON IT!!!

BLACK (HOT) ≈ 120V. ABOVE GROUND

WHITE ≈ GROUND

GREEN — CHASSIS GROUND (EVENTUALLY CONNECTED TO EARTH (PLANET) (WATER-SYSTEM)...



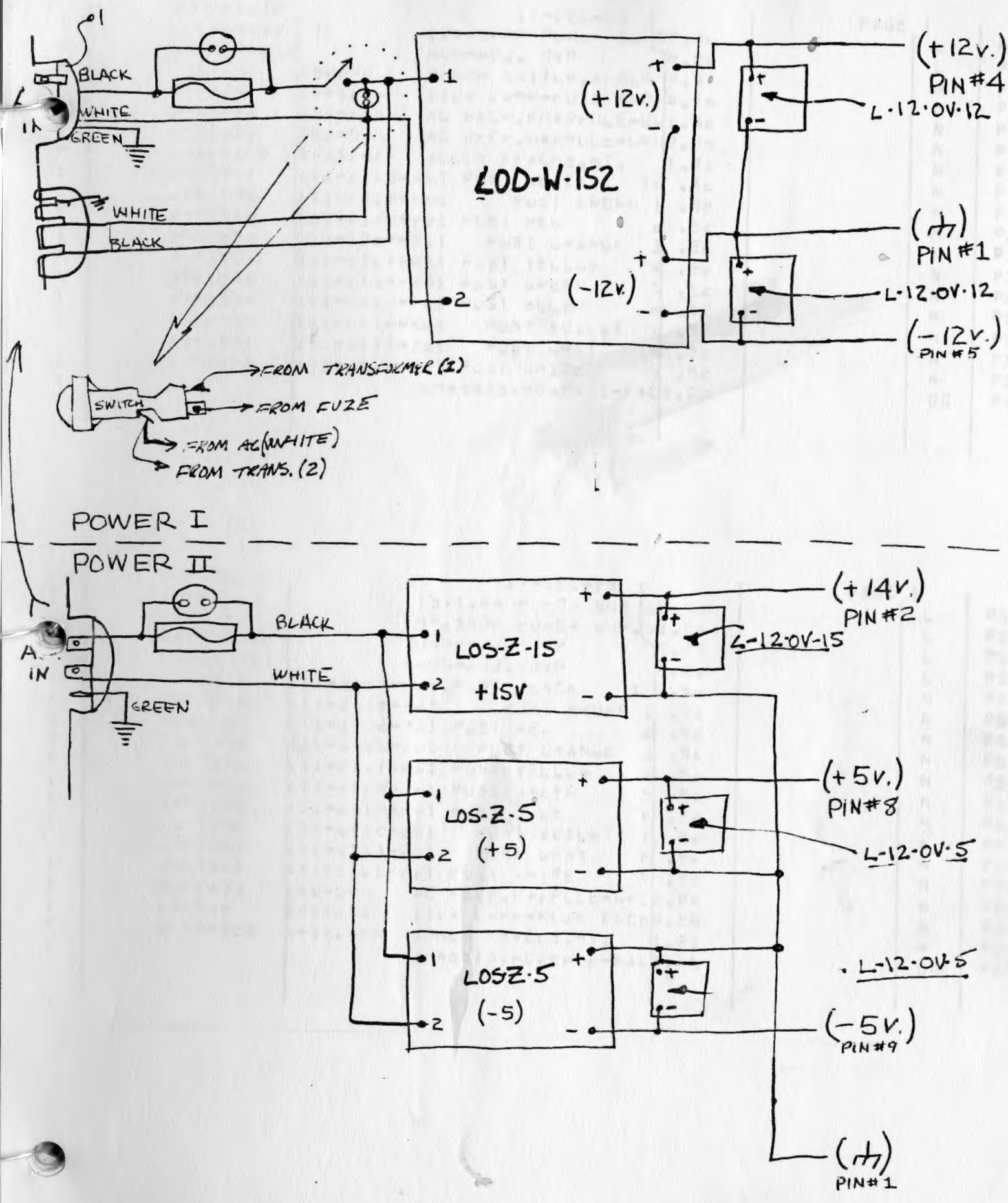
BLACK IS HOT LINE. THIS IS THE ONE WIRE THAT GOES THROUGH FUZE AND SWITCH.

WHITE IS RETURN.

GREEN IS CONNECTED TO METAL BOX. THIS SOMETIMES IS DONE IN THE FIXTURE ITSELF.

SILVER IS EQUIVALENT TO WHITE ON CONNECTORS.

COPPER IS EQUIVALENT TO BLACK ON CONNECTORS.


BLACK
WHITE
GREEN
WHITE
BLACK
LOD-W-152
(+12v.)
(-12v.)
(+12v.)
PIN #4
L-12-0V-12
(⏚)
PIN #1
L-12-0V-12
(-12v.)
PIN #5
FROM TRANSFORMER (1)
SWITCH
FROM FUZE
FROM AC (WHITE)
FROM TRANS. (2)
POWER I
POWER II
BLACK
WHITE
GREEN
LOS-Z-15
+15V
(+14V.)
PIN #2
L-12-0V-15
LOS-Z-5
(+5)
(+5v.)
PIN #8
L-12-0V-5
LOSZ-5
(-5)
L-12-0V-5
(-5V.)
PIN #9
(⏚)
PIN #1